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EXAMINATIONS AND SELECTION BOARDS

THE remarks which Sir Percival Waterfield, the First Commissioner of the Civil Service, made at Oxford in March regarding the low standard in personality and intelligence shown by applicants for entry into the Civil Service have aroused a considerable discussion and formed the subject of a debate on the Civil Service initiated by Viscount Mersey in the House of Lords on May 26. Sir Percival's statement that, of three thousand graduates interviewed, 40 per cent of those who wanted to go into the administrative service and 50 per cent of applicants for the foreign service scored marks for personality and intelligence which represented complete failure, is one of which industry and the universities as well as the Civil Service are bound to take careful note. His further statement that about five per cent of applicants for the administrative service and eight per cent for the foreign service were below even the lowest category may well be discounted, as was suggested in the debate, by war-time conditions and the absence of the screening which was practised by the universities with candidates for the written examinations; but the feature that, among those who failed, 60 per cent had university or college scholarships and 20 per cent were those who had State scholarships, should cause at least as much disquiet to the educationist and industrialist as to the Civil Service Commissioners.

The three fundamental questions which arise here were well indicated by Viscount Mersey in opening the debate: the training or education which the candidates have received; the tests or examinations to be applied to them when they desire to enter the Civil Service; and the qualities which are judged necessary for the Civil Service. This part of Lord Mersey's speech suggests that he was aware of the discussion on selection for management at the British Association meeting in Dundee last year. Neither he nor any other participant in the House of Lords debate, however, recognized that in selecting men for the Civil Service, or for any other walk in life, the chief requirement is, as Mr. A. Rodger pointed out at Dundee, a reasonably clear notion of what we are trying to assess. The first question to be answered is: "What are we looking for in our candidates?" Unless we can give a reasonably clear answer to that question, neither the written examination nor the selection board is likely to give us the men or women we require.

It might well be argued, therefore, that some of the criticisms of the selection—and rejection—of candidates for the Civil Service are due to the simple fact that, with the growth of the Civil Service and the increasing range and complexity of its duties, we have become less sure of the qualities we desire in our Civil servants, and less able to formulate precisely the relative weight we attach to initiative, integrity and other aspects of personal character for which no method of assessment yet exists, if, indeed, it could be found. We cannot expect to devise the appropriate methods of selecting and testing candidates while we are uncertain in our own minds about the precise

requirements those methods are to meet. Even if that uncertainty and indecision were removed, we have still a long time to wait before we can be satisfied of the validity of the new methods, as was, indeed, repeatedly asserted in the debate by the strongest supporters of the new tests.

There are, in fact, sound reasons why we should not discard the intellectual tests, however imperfectly such written examinations may disclose the boldness, quickness, clarity and candour which, with self-discipline, marked the habit of Greek thought in its greatest days, as Prof. F. A. Adcock noted in his presidential address to the Classical Association earlier this year. Indeed, Lord Lindsay very pertinently remarked that people who showed themselves capable of passing searching written examinations with distinction could not be altogether devoid of ability. He himself thought that while the interview by the Civil Service Selection Board was much better in many ways than the half-hour interview, the right course was to restore the solid evidence of achievement in the written examination and supplement the examination with the interview.

Whatever the ultimate decision, it seems clear that, as Lord Moran suggested, we are only at the very beginning of a method of assessing accurately the suitability of men and women for the Civil Service or for any other sphere. The task should be approached in humility, and it is of the first importance that we should arrange for the records of candidates to be followed up to see whether they meet the criteria of success for the various branches of the Civil Service. These criteria are not really known with any certainty; but the time and expense of validation should not be allowed to constitute obstacles in a matter of such general importance.

Lord Simon of Wythenshawe as well as Lord Piercy were confident that the new methods had proved their worth by helping the Final Selection Board to make fewer mistakes and a better selection. Nevertheless, we are only at the beginning, and it may be possible to devise an entirely fresh system. Lord Elton, for example, in urging once more that since character as well as intelligence is indispensable to all high achievement, character as well as intelligence should be the concern of the scholarship examination, directed attention to the Rhodes Scholarship system, which for forty years has been trying to do exactly what the Civil Service Selection Board is now attempting by the new methods. Lord Elton believes that the traditional tests were over-narrow in that they confined themselves to selecting persons likely to absorb readily and reproduce lucidly the ideas of other people. He emphasized that the Rhodes selection committees have been able to rely greatly on the school and academic record of the applicant, and that on none of these sixty or seventy selection committees was there a psychologist.

Lord Pakenham, who concluded the debate for the Government, had little difficulty in showing that Lord Elton had gone too far in implying that the Civil Service Selection Board should likewise dispense with the services of the psychologist. He indicated that particular importance is attached to studying the previous records of the candidates, and he promised that some sort of White Paper on the subject would be prepared. His speech itself gave an admirable account of the working of the methods at present used; and he submitted that the Government is taking the wisest course in trying out both systems and seeking to judge which system appears to select Civil servants who will maintain and enhance the great traditions of the public service of Great Britain.

Lord Pakenham's speech dealt mainly with this question of selection boards; but he made several specific statements of considerable interest. First, he said that the Departments of State were emphatic that they were getting very good material; but that the standard for the Home Service, and to a lesser extent for the Foreign Service, appeared to have been pitched too high. Accordingly, in the Home Service it had been decided to lower the pass mark slightly. The Foreign Service authorities, who had decided to rely on the selection board method for their recruits during the next few years, had not yet decided how to fill their much smaller gap. Lord Pakenham agreed with Lord Lindsay that in the post-war period many people had entered for the examination who would not have entered before the War; but he also said that a later and larger sample of candidates than that cited by Sir Percival Waterfield gave figures of 26·6 per cent and 30·7 per cent, respectively, of candidates for the Home and Foreign Services who passed the original qualifying test but who were finally graded as out of the running.

Nevertheless, although this is a slightly more encouraging picture than that given by Sir Percival Waterfield, the Government is proposing to review the national State scholarship system, and the Minister of Education has appointed a 'working party' to consider, in consultation with local education authorities and others, the various problems concerned with university awards. It is to be hoped that the 'working party' will grapple with the question of character which Lord Lindsay emphasized in this connexion, for it grows more important as the proportion increases of candidates coming from schools where there are fewer opportunities for the training of character than in the public schools, where it is traditional. Something must be done, as Lord Lindsay suggested, to secure that the State scholarships do not go to those who take no part in the ordinary activities of the school. Nor is the problem solely one for tackling at the secondary school level; Mr. J. W. C. Adams, warden of Crewe Hall, Sheffield, points out in the *Universities Quarterly* of May, that many of the universities could do more to encourage participation in the corporate life of the university, both by making halls of residence a more prominent feature of the civic universities and in other ways.

The debate in the House of Lords accordingly confirmed the value of the experiments in selection now proceeding; but it also underlined their experimental character and emphasized that the experiments must be so conducted as to permit judgment after a year or two of their reliability. Equally, it vindicated the very high standard of the university man at the present day: there was no evidence that

the universities are selecting the wrong people or training them wrongly, and the whole trend of the debate was against premature or excessive specialization, in science, the arts or any other field. Lord Cherwell in particular commended Sir Percival Waterfield's suggestion that no arts student should be without some knowledge of science, and no science student without some knowledge of the humane studies.

The increasing demands of the Civil Service on the trained man-power and woman-power of Britain raise the same problems of education and training. Just as the validity of the selection board's methods for the Civil Service is a matter of deep concern to industry, so the educational quality and attainments of the graduates from which both industry and the Civil Service are recruiting men and women are of much concern to them both. Nor indeed could the universities themselves be indifferent to the views of either industry or the State service in this matter, or attempt any considerable changes without having regard to both points of view.

The situation is already serious. It is clearly undesirable that an excessive proportion of the outstanding ability to be found each year among those leaving the universities of Britain should be drawn into any one section of life. It has already been suggested that the Civil Service is obtaining more than its fair share of the first-rate ability at present available. The nation is best served by a reasonable distribution over all those spheres of life which call for such gifts. Statements by Sir Lawrence Bragg and others have indicated some reluctance on the part of the ablest science students to enter industry. If such a tendency became too marked, the effect on industry would be serious. It would be equally unfortunate if industry itself attracted too large a proportion of our most gifted investigators and left the universities depleted in this respect.

Before the schemes of university expansion proceed too far, we should therefore reconsider the whole question of the aims and content of university education. Something more should be done along the lines that Dr. Percy Dunsheath attempts in his recent book "The Graduate in Industry"*. The graduate needs to be informed about the openings that exist in industry and the real conditions of work which obtain there; equally the industrialist does not always appreciate the contribution which the trained mind, when matured by experience, can make to industrial efficiency. Dr. Dunsheath has indicated many ways in which the university appointments boards could make invaluable contributions to the more effective use of trained man-power. From them, too, may well be expected some of the quantitative data by which we should revise our estimates for the rate and direction of university expansion, particularly if, as seems likely, difficulties arise in meeting the requirements for graduates in applied science suggested in the recommendations of the Barlow Committee on scientific man-power in 1946. Beyond this there is a wide field for research into the demands which various occupations make upon, and the scope they afford to, the various attributes of human personality.

The House of Lords debate is to be welcomed for putting the whole problem in its true perspective. It is not simply a question of the methods by which industry and the State can best select their recruits. Nor is it solely a question of the conditions which will enable the universities, industry and the State to attract to their service a fitting proportion of the ablest minds available from those graduating each year, or even of the way in which those men and women are to be trained and nurtured before they enter the universities, during their residence there, and in their subsequent careers. What stands out above all is that an unparalleled opportunity for experiment is in front of us, of which selection methods are only one facet. The problem of the development and wise use of the trained man-power and woman-power of Britain calls for the closest co-operation between industry, the State and the universities, as well as those institutions like the British Institute of Management and the National Staff Administrative College which are seeking to explore new methods and raise the whole standard of administration. Further, it should be remembered that, both in industry and in the Civil Service, the wise and full use of our ability involves increasing attention to its use and training after recruitment, so as to ensure that the keenness of young and able minds selected with so much care is not blunted by failure to use their talents to advantage, and in ways that afford satisfaction to their ideals as well as to their intellect and personality.

* The Graduate in Industry. By Dr. Percy Dunsheath. Pp. x+276. (London: Hutchinson's Scientific and Technical Publications, n.d.) 10s. 6d. net.

WHAT IS PHYSICAL CHEMISTRY?

(1) Rational Approach to Chemical Principles

By Dr. John A. Cranston. Pp. xii+211. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1947.) 8s. 6d. net.

(2) The Elements of Physical Chemistry

By Prof. Samuel Glasstone. Third printing. Pp. vii+695. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 25s. net.

(3) Physical Chemistry

By A. J. Mee. Third edition. Pp. xix+782. (London: William Heinemann, Ltd., 1947.) 20s.

(4) Physical Chemistry

By Dr. E. D. Eastman and Prof. G. K. Rollefson. (International Chemical Series.) Pp. viii+504. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 22s. 6d.

PHYSICAL chemistry emerged as a separate subject at a time when physics and chemistry were separated by a fairly wide *terra incognita*, and the application of physical and mathematical methods to chemical reactions and equilibria offered an attractive field which was catered for by neither of the parent sciences. It soon developed a homogeneous subject-matter of its own, which has remained the backbone of physical chemistry courses

ever since. It is natural that most of the new methods and fundamental conceptions of the behaviour of matter, which have contributed to the fuller understanding of chemical reactions and modes of combination, should have come from the experimental and mathematical branches of physics, and the role of the physical chemist has been to ensure the immediate and effective application of these methods and conceptions to chemical studies.

Now that the frontier between physics and chemistry has disappeared, the task of the physical chemist is by no means so clear. On one hand, the mathematical description of chemical combination has become a highly specialized branch of higher mathematics; on the other, the physicists have provided an armoury of weapons, such as X-rays, spectroscopes, mass spectrographs, electron microscopes, isotope techniques, etc., which are so demanding that their users tend to remain experts in their particular fields. In these circumstances, what should be taught to students as physical chemistry? Should it be those parts of physics which are most useful to the chemists? Or should it be the borderline region which concerns itself with the nature of chemical combination and the mechanism of chemical reaction —perhaps leaving the more mathematical aspects to the chemical physicist?

Faced with this vast and confusing extension, it is not surprising that teachers of physical chemistry have been much concerned with what to put into their courses and what they can safely leave out. That the times seem to many teachers to call for a re-orientation of physico-chemical studies is shown by the large number of recent text-books in which new interpretations have been offered of the subject.

The four books under review all reflect this tendency. Dr. Cranston's little book offers a new approach to physical chemistry in the school. He states his objective as follows: "It appears to the author that no more promising step . . . could be taken than ruthlessly cutting out the historical approach to the subject. The study then becomes a rational one. The physicist's atom is taken as the starting point and a reasonably detailed picture of its structure is drawn. The fundamental laws of chemistry . . . then tumble out of the picture in a perfectly rational way." The reviewer thinks that Dr. Cranston has justified his claim except in one respect. The introduction of the atom first has led him to describe the quantum numbers of the atoms in the periodic scheme on p. 21, while it is not until p. 80 that we are introduced to the conservation of energy or even the units of energy. Surely it is asking a little too much of the intuition of even "the average school boy, who, in an age of wireless, is already familiar with many aspects of electricity", to expect him to make any sense of the distinction between magnetic and spin quantum numbers, at the very beginning of his studies. A very simple picture of the atom would be adequate for everything which follows.

How to deal with atomic structure, in fact, presents a difficulty to all these authors. It obviously comes within the category of "those parts of physics which are most useful to the chemist", forming, as it does, the whole basis of his conception of matter; but it does not fit in very well with the more usual curriculum of physical chemistry which follows. Both Glasstone and Mee tackle this question at or near the beginning, but Eastman and Rollefson, for some reason, interpolate it between the liquid state and solutions. The reviewer would suggest leaving it out of text-books of physical chemistry entirely, and letting it be studied, empirically treated as it is, under *inorganic* chemistry. Those students who want to delve deeper should be encouraged to get help and inspiration from their physics departments.

Prof. Glasstone's book, a new addition to his series of text-books, is in a style familiar to his many readers, and provides, at a more elementary level than his "Text-book of Physical Chemistry", a clear and straightforward account of the subject. Its references for further reading are entirely to articles in the *Journal of Chemical Education*—a fact which makes it less suitable as a text in Great Britain than across the Atlantic. A further feature is the large number of revision questions, which enable the student to test his knowledge and perhaps anticipate his examiner's choice.

Mr. A. J. Mee's is a new edition of a well-known book, which will require no recommendation to users of the previous editions. The text of Profs. E. D. Eastman and G. K. Rollefson is perhaps the most comprehensive of the four books under review, as may be judged from such entries as the radial distribution of atoms in silica glass, infra-red frequencies of chemical bonds, and tracer studies with radioactive atoms. Readers can decide for themselves whether the book covers adequately the seven objectives of physical chemistry which are listed in the first chapter. Space does not permit quoting these in full, but how widely the authors interpret the subject can be judged from their seventh objective: to describe, interpret or predict . . . "the molecular, atomic and subatomic structure of the constituent particles"!

The last three books might well have given more space to the rapidly expanding applications of physical chemistry in the biological field. Out of about 700 pages, Glasstone devotes 24 to the colloidal state and Mee about 29, while Eastman and Rollefson do not mention it (they have a brief chapter on surface phenomena). This is inadequate at a time when chemistry is becoming increasingly concerned with larger molecules, both of living and of non-living origin.

The most striking feature of these and of other recent text-books of physical chemistry is the fact that they adhere so closely to the traditional curriculum. Writers of introductory texts are naturally concerned mainly with the past, and are wise not to concentrate too much on ephemeral 'recent advances'. Perhaps it is asking too much to expect them to distinguish the trend of the present day and so anticipate the future needs of the present generation of students.

J. A. V. BUTLER

APPLIED ELECTRONICS

Electronic Circuits and Tubes

By the Electronics Training Staff of the Cruft Laboratory, Harvard University. Pp. xxiv + 948. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 45*s*.

THIS book sets down, in nearly 1,000 pages, the greater part of the war-time course given to U.S. officers at the Cruft Laboratory, Harvard University. The range of material included is necessarily very great and, as Prof. Chaffee has frankly stated in his foreword, ". . . the scope and

the method of presentation of the material in this volume are not on a graduate level. . . ." Indeed, this could not possibly be so in a single volume which includes: A.C. vector theory; bridge and other measurements; transient analysis; network theory; wave-filters; thermionic emission; electron dynamics; transmitter and receiver circuits; gas-discharge tubes; modulation theory; timing, rectification and control circuits. The treatment is essentially technological and, in many places, merely descriptive.

The recent flood of books on the more technological aspects of electrical communications makes one search any new publication for positive contributions to the art; in this respect, this book is saved by certain novel treatments. In particular, attention may be directed to the use of surface models in connexion with coupled circuits, and to the simple approach to the problem of transients and signal distortion.

Against these favourable points must be weighed the very condensed and sketchy treatment of certain topics. Thus, magnetrons are dealt with in one page, while klystron and other micro-wave tubes are omitted (in spite of the title). Transmission line theory has been included in a companion volume dealing also with wave-guides and antennæ, and this has necessitated treating wave-filters from the beginning as finite structures, which, though the more practical condition, results in an unwieldy presentation likely to be confusing to the beginner.

To two appendixes are relegated the elements of the relevant mathematics, electricity and magnetism: Appendix (*a*) opens with the definition of powers of a number and meaning of logarithms, and Appendix (*b*) with the inverse square law. If it be assumed that the reader needs to start at such elementary levels, it is unlikely that he will learn much from such intense cramming. It would have been preferable to have used this space for expanding the main text, giving references to good elementary text-books which might supply the foundations.

The urgency of the War required the rapid training of great numbers of people, with varying backgrounds, in the application of electronic techniques. But the value of such a course is doubtful now. Nevertheless, there must be many scientific people, possessing a suitable grounding in mathematics, electricity and magnetism, who may be interested in applying such techniques to their particular branch of science. For them, this volume may serve as a reference book and as a guide to the literature. There are a few, but select, references and a clear index; the diagrams are good, and the style is consistent in spite of the joint authorship.

E. C. CHERRY

METABOLISM OF DRUGS

Detoxication Mechanisms

The Metabolism of Drugs and Allied Organic Compounds. By Dr. R. Tecwyn Williams. Pp. viii + 288. (London: Chapman and Hall, Ltd., 1947.) 25*s*. net.

THIS is the first monograph to be published in English describing the chemical changes which drugs or other substances foreign to the body undergo when administered to animals. It is undoubtedly a useful compendium of the work which has been carried out in this field. Dr. R. T. Williams excuses his title on the grounds that the subject has been treated under such a heading in text-books of biochemistry. The title is, however, too narrow for the subject. Many of the reactions considered are certainly not detoxication processes. Thus the conversion of the azo dye prontosil into sulphanilamide appears to be an activation, and the metabolism of some substances such as picric acid and trinitrotoluene leads to more toxic products. The functions of the biochemical changes are unknown in most cases. "Detoxication Mechanisms" is rather a teleological expression, and the reviewer would like to suggest that another title or even the present sub-title be used for future editions. Even if it has become customary to use this term, there is no need to continue using a term which Dr. Williams admits if "Taken in its literal sense . . . becomes in many cases a misnomer".

The metabolic processes which are described include oxidation and reduction and synthetic reactions such as the formation of thiocyanate from cyanide of acetyl and methyl derivatives of amines, and conjugation with glucuronic acid, sulphate, glycine, acetyl cysteine, ornithine and glutamine. The changes are considered particularly in reference to different groups of compounds, according to whether they are aliphatic or aromatic and the nature of their substituent groups.

The changes which most normal body constituents undergo, such as phosphorylation or oxidation, are often the same in all species, from bacteria to the higher mammals. The changes undergone by drugs and purines, however, show remarkable differences. Thus phenylacetic acid is conjugated with glycine by most mammals but with glutamine by men and chimpanzees and with ornithine by fowls. Aromatic amines are acetylated by most animals and birds, but not by dogs. The metabolism of β-naphthylamine shows interesting differences. When given to dogs, in which species it induces cancer of the bladder, it is excreted as 1-hydroxy, 2-amino derivatives; but in rats, rabbits and monkeys, in which bladder cancer has never been induced with this compound, 6-hydroxy, 2-acetylamino-naphthalene is produced.

The biochemical changes which synthetic substances undergo in the body give an indication of capabilities which would otherwise pass unrecognized. Thus the acetylation of amines is most easily demonstrated with foreign substances such as the sulphonamides. The study of the metabolism of phenyl-substituted fatty acids gives indications of the metabolism of fatty acids in the body. In this case the phenyl group acts as a tracer. Dr. Williams considers that there is no satisfactory unitary theory for the processes considered. Substances foreign to the body are probably changed chemically because they resemble natural body constituents sufficiently closely for them to become substrates of existing enzymes. A fresh drug may stimulate the body to produce a fresh enzyme by adaptation, but in many cases animals metabolize foreign compounds as soon as they are administered.

Dr. Williams has produced a useful compendium of the facts of the subject which will be of value to many biologists with interests in pharmacology and chemotherapy. When more facts are known, it might be possible to generalize and introduce satisfactory hypotheses for the innumerable chemical processes which the animal body can carry out.

E. BOYLAND

Modern Rubber Chemistry

By Dr. Harry Barron. Second edition. Pp. viii + 502. (London: Hutchinson's Scientific and Technical Publications, 1947.) 36*s*. net.

The Water-Soluble Gums

By Dr. C. L. Mantell. Pp. v + 279. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 36*s*. net.

IN "Modern Rubber Chemistry" Dr. Barron covers an immense field, stretching his title to include such topics as fabric construction, mould design and physical testing. The author's intention of being understood will be largely achieved, but there are some repetitions and examples of careless writing. A more selective account of early work would permit a clearer treatment of the scientific principles underlying, for example, the structure of rubber and the theory of vulcanization. The work of Farmer and his co-workers on this latter topic is surprisingly omitted. The useful analogy of likening the process of polymerization to the joining of hands is weakened by an unnecessary reference to chain formation through secondary valencies. The work as a whole can, however, be recommended as a valuable text-book on the technology of rubber.

Accompanying an increased insight into the structure and properties of synthetic polymers, our knowledge of many naturally occurring substances has been greatly enriched in recent years; indeed, many significant advances in high polymer science have resulted from studies on cellulose and natural rubber. It is of interest to note that while Dr. Barron turns to current high polymer theory to clarify some of the obscurities of rubber behaviour, this approach is not evident in Dr. Mantell's work.

"The Water-Soluble Gums" is a comprehensive account of the sources, collection, manufacturing processes and applications of a class of substances obtained mainly from plants. Gums are here described loosely as hydrophilic colloids, and it seems possible that the scope of the subject might be better defined by the phrase "Water-Soluble High Polymers". This definition would necessarily include polyvinyl alcohol, which is rapidly assuming importance, particularly in the United States, as a 'synthetic gum'. In general, the treatment of the subject is somewhat uncritical, and recent work on chemical constitution is not adequately described.

Volumetric Analysis

By Prof. I. M. Kolthoff and V. A. Stenger. Second revised edition. Vol. 2: Titration Methods; Acid-Base, Precipitation, and Complex-Formation Reactions. Pp. xiii + 374. (New York and London: Interscience Publishers, Inc., 1947.) 36*s*.

THE issue of the second revised edition of this standard work on volumetric analysis will be welcomed by a wide circle of analytical chemists. The book under review, the second of a set of three volumes, confirms the favourable reception accorded to the first edition.

This volume is divided broadly into three parts: (*a*) apparatus and general principles describing equipment and technique needed to achieve the best results with volumetric methods; (*b*) acid-base reactions, which include standard titrations and reactions involving displacement, hydrolytic precipitation and complex formation; and (*c*) quantitative precipitation and complex formation reactions in which titrations with silver nitrate, potassium ferrocyanide and many other reagents are described.

Within the scope of this book, which does not include oxidation-reduction methods, the treatment is very comprehensive and contains a wealth of practical detail and shrewd comment. Many references and notes are included, but, as the authors point out, the lack of information during the war years has prevented a full description of work published outside the United States since 1940.

This book is recommended with confidence not only to analytical chemists but also to workers in other branches of chemistry.

Chemistry in the Service of Man

By Prof. Alexander Findlay. Seventh edition. Pp. xx + 390. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 12*s*. 6*d*. net.

THE appearance of a seventh edition of this widely read book is timely and welcome. It has long been recognized as a valuable general account of the way in which the science of chemistry helps to meet the needs of mankind. Advances, both scientific and technical, have been so rapid of late that it is essential for the subject to be reviewed at frequent intervals, all the more so because of the effect of war.

Prof. Findlay has carried out such a review admirably in this latest edition. He handles his vast theme with authority and skill. A wise selection of material has been made, and the subject-matter has been kept up to date without a loss in the general balance.

As in previous editions, sound scientific treatment is happily married with a most agreeable ease of style.

Honey and Your Health

A Nutrimental, Medicinal and Historical Commentary. By Dr. B. F. Beck and Dorée Smedley. Pp. 231 + 21 plates. (London: Museum Press, Ltd., 1947.) 12*s*. 6*d*. net.

THIS book is really a companion volume to the late Dr. Beck's earlier work "Bee Venom Therapy". Although it is difficult to accept some of the author's views with regard to the nutritional advantages of honey over other mixtures of sugars, it is almost impossible not to become infected by his enthusiasm, and to enjoy reading the folk-lore about honey which he has collected together from so many parts of the world. His history of the uses to which honey was put in bygone times makes fascinating reading and will, I feel sure, give pleasure to many people besides those who keep bees. Incidentally, this book contains some excellent recipes in which honey plays a major part.

COLIN G. BUTLER

Sociology of Religion

By Joachim Wach. (International Library of Sociology and Social Reconstruction.) Pp. xii + 429. (London: Kegan Paul and Co., Ltd., 1947.) 30*s*. net.

THE author summarizes and reviews the literature dealing with the forms, social expressions and general social relations of religion in all its various manifestations. It is a work of immense erudition. The index occupies 29 pages and the number of footnote references is (roughly estimated) 5,000. As a work of reference it is undoubtedly useful and well worth publishing. It is very doubtful, though, whether anyone will have a better understanding of religion after reading the book than he had before, or even a better understanding of sociology.

A. D. R.

THE INDIAN FOREST SERVICE

By Prof. E. P. STEBBING
University of Edinburgh

THE passing of the British forest officer from India, where a succession of young men possessing that British intuitive love of an open-air life, with a touch of the adventurous in it, has built up a magnificent forestry property for India, merits a record. It has been a work which has had a minimum of publicity, due perhaps to the failure of the forest officer (until comparatively recently) to write for the public.

The history and work of the British forest officer in the teak forests of Burma was reviewed in *Nature* of December 13, 1947 (160, 818). Earlier, in *Nature* of September 8, 1945 (156, 286), an article on "Post-War Forest Policy in India" was published. When the memorandum discussed in the latter article was written by the Inspector of Forests to the Government of India, the decision as to the future political division and status of the country had not been settled, and it was considered likely, in fact probable, that many British forest officers in the different provinces would continue to serve out their time under whatever Indian government or governments were set up. This, in the event, has not proved generally to be the case.

The history of the forests of India from the practical point of view commences with the introduction of British administration into the country after the defeat of the French; as distinct from the earlier days of the East India Company, which only maintained trading posts at Bombay, Madras and Bengal. It was after the defeat of Tippoo Sahib in 1799 at Seringapatan in the south that British administration spread throughout a large part of Madras, and was accelerated in portions of Bombay and lower Bengal. The administration extended almost in spite of ourselves, the forward progress being necessitated if the areas already under British rule were to be safeguarded; it was not premeditated.

The gradual extension of British rule soon began to have its effect on accessible forests. The partition of the provinces into divisions and districts necessitated the erection of headquarters buildings in each, the construction calling for large amounts of timber. The military authorities required timber for many purposes, while the Admiralty at home and the smaller dockyards around the coast of Britain and at Bombay were soon taking increasing amounts of teak timber from the forests in the south, Malabar, Travancore and southern parts of the Central Provinces and Hyderabad, etc. The population of India, now living under settled conditions, rapidly increased in numbers, and in their old-time demands on the forest for fuel, grazing and small timber. In the south, teak was the only timber in use. It was the difficulties in meeting the requirements of the Naval dockyard in Bombay that resulted in the appointment of Dr. Gibson as *ad interim* conservator of forests in Bombay in 1844, with an assistant conservator and small office establishment; these were the first appointments of the kind in India. Gibson was confirmed conservator of forests in 1847. In Madras it was not only the Government's and Army's annual teak supplies which were causing the gravest concern, but also the scarcity of firewood for Madras city and the hill station at Ootacamund which eventually led to the appointment of Dr. Cleghorn as conservator of forests in 1856. He was given three assistants. Shifting cultivation was rife in both presidencies when the British took them over. It was due to their efforts that this wasteful utilization and destruction of the forests had been, to a great extent, eliminated by Government order by 1860.

In the northern half of the country on the eastern section, sal (*Shorea robusta*) was the only timber in common use, and Government departments, in the absence of teak, would only take this type, while in the north, Punjab, etc., the chief timber in common use was the deodar (*Cedrus deodara*) brought down from the outer Himalaya. The partial disappearance of the accessible teak forests in Malabar, on the west coast of Madras, was the first intimation that forests were not inexhaustible, and from the middle thirties of last century, the recognition that some form of control would be necessary was gradually forced upon the Government of India, not only in connexion with the large annual Government requirements in the three timbers mentioned (the deodar after the capture of the Punjab in 1850), but also to safeguard the requirements of the population itself throughout much of the country.

Many attempted panaceas in short-term measures, to tide over sudden emergencies, were made before the position was faced squarely by the Secretary of State for India at home and the Governor General in India. The Indian Mutiny had come and gone, with, as a main first step, the commencement of the building of the Indian railways, for which large amounts of timber would be required, threatening, if left in the hands of timber contractors, to result in the extinction of large areas of timber forest. Correspondence between the Governor General and the Secretary of State, Sir Charles Wood, in 1862–63, resulted in the formation of the Indian Forest Service, and the appointment of Sir Dietrich Brandis as the first inspector general of forests. But it was one thing to create a forest service on paper and another to fill its ranks and to lay down the powers and duties of the new Service in connexion with the districts in which forests were situated, hithertofore entirely under the charge of the Civil district officer. From the first it was laid down that a conservator of forests should be appointed to each province (save where already in existence), his duties to be administrative and advisory to the lieutenant governor in charge of the province; and that the provinces should be divided up into a number of forest divisions, each under the executive control of an assistant conservator of forests. In the first instance, the new Service was filled by young men volunteering from the Army, the newly disbanded Indian Navy, and other sources. Many of those so appointed had some experience of the forests gained on private shooting expeditions. This served as a start; but Brandis soon realized that the fully trained forest officer would be required to introduce and maintain an effective organisation in the country. In the late sixties, with the consent of the Secretary of State for India, he commenced choosing yearly a few young men with sufficient acquaintance with scientific subjects—botany, zoology and so forth—who received their forestry training in France or Germany. In 1885 home training was started at the Royal Indian Engineering College, Coopers Hill, where it remained until 1905, after which probationers were trained at the University of Oxford, and eventually also at Cambridge and

Edinburgh. This training of British probationers for the Indian Forest Service persisted until about 1933; some Indian probationers were also trained in Britain, and eventually entered the Service up to 1939. Up to the outbreak of the First World War, the India Office advertised the number of probationers required annually, and the annual quota was selected before the specialized training commenced. It was this consistent policy, maintained throughout so long a period, that produced a fine body of men who have, through the years, built up and brought to its present position the magnificent forest estate in existence. For now it can be readily recognized that it was the action of the Secretary of State and the Governor General in the early sixties of last century which saved the forests of India from extinction in all accessible (to the timber market) regions, while the smaller areas in the vicinity of villages and small towns would quickly have disappeared.

Perhaps the four most important steps taken in the pre-Forest Service period were the formation of the very successful Nilumbur teak plantations, initiated by Conolly, Collector of Malabar in 1843; the public recognition by Cleghorn, a few years after his appointment as conservator, that sylviculture must be introduced into the management of the Indian forest; and the recognition of the damage done to the forests by the shifting cultivator, and the virtual suppression of the practice throughout the greater part of Madras and Bombay. Lastly, the growing realization and conviction of the Government of India between about 1840 and 1860 that the forests of India at the time accessible to exploitation of all types, including the provision of fuel and grazing required by the rapidly rising population, which was primarily agricultural, were not inexhaustible.

After its inauguration, the Indian Forest Service made considerable headway during its first decade. Apart from the constant support and driving force of successive Secretaries of State for India at home, there can be little doubt that the rapidity with which it got fairly settled in the saddle was due to the policy of railway construction adopted at the period. Buildings were required and wood fuel for the engines; also the sleepers for the tracks had at this time to come from the forests in the regions concerned, teak, sal and deodar. The unchecked exploitation of the forest by the timber merchant had been stopped. The brunt of the organisation for this enormous quantity of timber required fell on the young Department, and its energetic chief, Brandis. It is an Odyssey in itself, both the work and the names of the men mainly associated with it.

Some of the work during the first thirty years has already been dealt with in the article in *Nature* on "Post-War Forest Policy in India" referred to above. The main work of the Department, apart from exploitation and providing for the requirements of the people, lay in selecting and, after sanction, demarcating the forest reserves and protected forests in different parts of the country (including Burma), in laying down and cutting a network of fire traces for their protection, and in the division of the forest blocks by lines or rides into the unit of working and supervision termed the 'compartment'. This was a gigantic task which in the main was completed by the end of the century. To enable forest reservation to be legal, a special Indian Forest Act VII of 1865—amended by Act VII of 1878—was enacted. Separate Acts were passed for Madras, Bombay and Burma. The fire protection policy, the first attempted in a tropical country, was based on a first successful attempt to protect the Bori teak forests in the Central Provinces from fire during the hot weather season. At the period, fires ran unchecked across the countryside in India during the hot weather, and the consensus of opinion held that it would be impossible to protect the forests from their customary baptism of fire. Forest officers of those decades can tell of the hardships of fire-fighting during the hot weather months. But great results were achieved.

During the latter part of this period in the more advanced forests of the country it was possible to give up departmental exploitation and introduce the method of marking standing trees in the forest for sale, their felling and removal being undertaken by the purchaser, thus enabling the forest officer to turn to a study of the sylviculture of his forests, and other professional duties. It was in this way that a beginning in the preparation of working plans took place in India. From the appointment of Brandis in 1863 as inspector general of forests, to the end of the century, three men occupied the post, himself and two other Germans, W. Schlich, and B. Ribbentrop, who had been recruited as fully trained young German forest assistants, and sent out to India in January 1870. Schlich held the post only for a couple of years, 1883–85, when he accepted the appointment as professor of forestry at the newly organised forestry school at the Royal Indian Engineering College at Coopers Hill. Ribbentrop held the post with distinction up to 1900.

The next great departure, and one which on considering the history and order of the progress would have been misplaced had it occurred earlier, that is, before the reservation of the bulk of the forests contemplated had been achieved, was the formation of the Imperial Forest Research Institute by Lord Curzon in 1906. By now the officers in charge of the forest divisions throughout the country had much more time to give to purely forestry problems, and moreover, in the more advanced forestry areas they had the advantage of ranger executive officers who had been trained at the (N.C.O.) ranger's class at the Dehra Dun Ranger's College, instituted in 1885. Many of the divisional forest officers had problems which urgently needed study by the research officer. Sir Sainthill Eardley Wilmot was the inspector general of forests at the time, and to him and the Viceroy belongs the credit of taking a step which was to have widespread ramifications, although it is impossible to go into the matter in detail. When Curzon asked the Inspector General where he was going to get his research officers from he replied, to the Viceroy's expressed amazement, "from the Forest Department". The Agricultural Research Institute for India had been inaugurated a few years before, also under the ægis of Curzon; but its officers had all to be recruited from home. One outcome was the new research building, built at Dehra Dun and opened in 1912, which quickly made its value apparent during the First World War—so much so that at the close of that war a new building on a far larger scale, outside Dehra town itself, was projected and sanctioned by the Government of India at a cost of one million pounds. This has been functioning for many years, and once again, during the Second World War, was its value to India and the fighting forces fully shown. The introduction of research as a part of the work of the Forest Department necessitated some form of publications of the investigations achieved. These are now well known. During the previous century

there were no official publications of the Department. *The Indian Forester*, a monthly magazine, started in 1885 and still issued, was a private departmental publication.

As research work progressed, it gradually became obvious that some decentralization would be necessary; for example, one or more provinces might have a major sylvicultural problem requiring study by the sylvicultural research officer. Even with the assistance provided at the Institute, it was not possible to answer all calls. The selection and appointment of local research officers in the provinces which required them was sanctioned, and thus came into being the local research, sylvicultural, forest entomologist, and utilization officers, and, as important as any, the provincial conservator of working plans. These officers kept in close touch with Dehra Dun.

Reference was made in the article in *Nature* on the teak forests of Burma to the great progress made in working the forests under carefully prepared working plans. In India, by the opening of the Second World War, a network of plans for the forest reserves was in force, and many of these had been revised more than once. Since their early and tentative introduction, great advances had been made in the scope and intensity of management of many of these plans. The one *sine qua non* of the working plan, if properly prepared, is that all over-felling is permanently checked. Briefly, only the annual yield, that is, the annual increment put on the trees, is cut. In the memorandum on "Post-War Policy in India, 1944", the Inspector General of Forests was able to write on the subject of excess war fellings in the Government reserve forests in India: "Little is required to restore the departure from normal, that is the excess War Fellings; a 40–50 per cent reduction in pre-War yields for a period of five to ten years, may in some cases be necessary. The true position can be determined by the revision of the Working Plans which must, therefore, be accelerated after the War." This is forestry management brought to a high standard of efficiency.

Lastly, since the financial aspect of this great undertaking by Government forms one of its aspects, the following figures speak for themselves:

Revenue in 1868–69 = Rs. 40,38,800 and Surplus Rs. 12,65,467.
Revenue in 1936–37 = Rs. 4,38,07,019 and Surplus (last year before separation of Burma) Rs. 1,53,58,194.

In addition, forest produce to the value of Rs. 84,14,946 was given away free or at reduced rates during 1936–37.

This article has no concern with political questions. It is merely a parting—a farewell to the Indian Forest Service. But in the light of the long experience I have been fortunate to have had in following the progress of the management of the forests of India, and in the study I have been able to make of the history of those forests, it may not be out of place to put out a word of warning. In the case of forests in which the management has been brought along the road to efficiency in working, as understood by the forester using these words, there can be no standing still, no relaxation of supervision, either by the gazetted officer in charge or his chief ranger executive officer, and no delegation of important sylvicultural operations—the constant inspection, for example, of young crops of regeneration until they have passed out of the danger period, the marking of thinnings upon which the whole future of the timber crop depends, and so forth—and equally and all-important, no over-felling, even in an emergency, without a full recognition by the higher authority of its necessity. These are fundamentals. That they have not only been introduced but also maintained in the Government forest estate in India, the Second World War has effectually proved.

I would say this to India and Pakhistan. The British forest officer has built up not only a great legacy which he now makes over to the owner, but he has also brought it to a pitch not, I believe, existent in any comparable area of forest in the world. If it is a proud legacy to leave behind, it is an equally proud one to take over. In the hands of the India and Pakhistan forest officers, the world will watch with interest the further great progress to be achieved, a progress which will afford lessons in tropical forest management for both the executive forester and the research officer, wherever he may be working.

THE WORK OF THE NATIONAL PHYSICAL LABORATORY

THIS year, 'open days' at the National Physical Laboratory were held on June 21 and 22. On the first day representatives of industry, including many from organisations having no previous contact with the Laboratory, took this opportunity of seeing the large variety of research and investigational work that is undertaken. On June 22, the occasion of the annual inspection by the Laboratory's General Board, of which the president of the Royal Society is chairman, the visitors included members of the scientific staffs of universities and Government departments.

During the last twelve months the work of the Laboratory has been concentrated so far as possible on those short-term projects of the greatest immediate benefit to industry, although much has also been done during the year on the maintenance of the various national standards and on programmes of fundamental research. No outstanding new developments were on show, but the two hundred and seventy-two scientific exhibits well illustrated the work of the Laboratory's ten divisions, and mention will be made of a few of the more interesting items.

The aerodynamical work on the design of the proposed Severn Suspension Bridge, one of the most interesting exhibits in 1947, has now been transferred to an outstation where scale models are undergoing test in a large wind tunnel. The work of the Aerodynamics Division is largely concerned with problems of high-speed flight, and exhibits in the various tunnels demonstrated the work being done to improve flying performance by the use of specially designed low-drag wings and boundary-layer control by suction or blowing. Researches into problems of stability, control and flutter, increasingly important at high speeds of flight, are being carried on and a model 'xylonite' elastic wing, incorporating the major structural characteristics of a typical aeroplane wing, is used in the study of the twist of a wing caused by a change in distribution of the air loads and its effect on the response of the aeroplane to movement of the ailerons.

The Metrology Division has just completed for the first time since 1932 a comparison of the national copies of the Imperial Standard Yard and the International Metre with their respective principal copies.

Using specially devised equipment, a new high standard of precision has been attained. Interesting experiments carried out in the United States have established that when gold is irradiated with neutrons in an atomic pile, an isotope of mercury is produced which yields almost ideal monochromatic radiations when electrically excited. It will be possible in due course to propose replacement of the existing material standards of length by definitions in terms of the wave-length of this particular radiation.

Among the new machines made and designed by this Division was shown a floating-micrometer for measuring the diameter and rate of taper of tapered plug screw gauges.

An interesting new development in the Engineering Division is the setting up of a photo-elastic laboratory. The equipment on show included a photo-electric photometer for accurate measurements of the photo-elastic patterns. Work on heat transfer in pipes using mercury as the working fluid, started in 1938 but dropped during the war period, has recently been resumed, using an all-steel double-flow heat exchanger.

A strain-operated electronic trigger device designed in the Division was in operation on one of the special machines installed in the Lubrication Laboratory. This device will stop the machine should an increase in frictional force above a critical level indicate that seizure of the bearing under test is imminent. Small variations in strain of a weighbar are converted to voltage changes by an electrical resistance strain-gauge circuit, and when the strain exceeds a certain predetermined magnitude an electronic trigger is tripped which stops the machine before serious damage occurs. The principles underlying the operation of this device are thought to be applicable to a wide range of machines where the imminence of an unsafe condition may be accompanied by increase of linear strain in one element of the machine.

In the Physics Division the work of the radiology section on the protection of operatives against ionizing radiations and on the measurement of radio-activity is growing in importance with the increased availability of radioactive substances, and a comprehensive range of measuring and standardizing equipment was on show.

During the past year, further progress has been made with the extension of the section dealing with the fundamental work on acoustical standards of measurement. Among other developments which were on view was a room which has been provided for the standardization of microphones and other acoustical instruments. The walls of this room are lined with wedge-shaped absorbent constructions of the type now recognized to be exceptionally effective in suppressing reflected sound, thereby permitting field measurements of the highest accuracy.

A new quartz spectrograph has been installed in the Metallurgy Division, and together with a micro-photometer and a precision comparator forms the main equipment of the Spectroscopic Laboratory. One of the interesting activities of this Division is the preparation of new materials and the study of their properties, and attention is now being given to the preparation of the metals vanadium and titanium in a state of high purity. Little is known, so far, of their physical properties and metallurgical behaviour, and this investigation will yield useful fundamental data.

Another notable exhibit was a projection microscope adapted to phase-contrast illumination. In this form high parts of the structure under examination are revealed as bright areas; the low parts dark. Light reflected by the specimen is split into two parts, one being advanced in phase a quarter of a wave-length relative to the other by means of a 'phase-ring' in the objective lens. The two beams are re-combined and the interference between them produces the typical phase-contrast effect. The satisfactory working of the method calls for the replacement of the ordinary disk aperture by one of the ring type. The images are similar to those given by the electron microscope and so help towards appreciating the difference between electron microscope and normal optical microscope images. The phase-contrast microscope is capable of being sensitive to steps of surface-level of about 50 A.

The Electricity Division had on show equipment for extending the range of quartz-controlled oscillations to centimetric wave-lengths. A number of stages of frequency multiplication, mixing and amplification are used to obtain sources of oscillation of a power of about 3 watts having frequencies, controlled by the primary standard, of the following values: 33·6–36·8 Mc./s. in steps of 0·4 Mc./s., 67·2–73·6 Mc./s. in steps of 0·8 Mc./s. and 201·6–220·8 Mc./s. in steps of 2·4 Mc./s. By using these oscillations and their harmonics up to the order 36, controlled frequencies are obtained throughout the range 350–8,000 Mc./s. at intervals of 1 per cent. A variable frequency oscillator, monitored by the standard, enables values between the controlled frequencies to be obtained without appreciable loss in accuracy. Two further stages to be added will extend the range to 50,000 Mc./s.

The most obvious application of the equipment is the rapid and precise calibration of wavemeters, but the sources at their fundamental frequencies will also serve for the testing of cables and dielectrics. An application of more fundamental importance may be the study of the radio-frequency spectra of atoms and molecules. The spectra of a number of gases have been examined both in Great Britain and the United States during the last three years, and that of the ammonia molecule, for example, has lines in the neighbourhood of 23,000 Mc./s. the frequencies of which have been measured to a precision of 1 part in 10^6. Such lines can be used as standards of frequency, and the possibility of obtaining molecular standards of this kind is exciting considerable scientific interest.

In the High Voltage Laboratory, measurements of the time variation of the light from sparks are being made by means of a photo-multiplier, amplifier and cathode ray oscillograph. The immediate purpose is to provide a spark suitable for shadow photography in the Aerodynamics Division. The effects of electrode material and spark current are being studied and observations are being made on a gas discharge tube suitable for light pulses of 1 micro-second duration.

The Radio Division has developed a cathode ray direction finder for the location of thunderstorms at long ranges. The apparatus exhibited is similar to that used by the Meteorological Office and is of great value in problems such as the routing of aircraft over the Atlantic. A symmetrical arrangement of orthogonal loop aerials is connected to a twin-channel superheterodyne receiver which is tunable over the frequency range 10–30 kc./s., the normal operating frequency being 12·5 kc./s. At this frequency a minimum field-strength of 100 μV./m. (approximately) is required to give a full-scale trace on the cathode

ray tube; but for normal operation on atmospherics in Britain, the balanced attenuators incorporated in the equipment are adjusted so that a full-scale trace is given by a field-strength of about 5 mV./m. Visual observation of the bearing on the cathode ray tube is generally employed, but the equipment can easily be adapted for photographic recording.

The Mathematics Division exhibited the comprehensive range of machinery that it has available for computational work; one room was devoted to an exposition of relaxation methods, which have a wider application than is generally supposed. The Division is also able to offer advice on the application of statistical methods to various research problems.

The work of the Ship Division continues to be directed mainly to satisfying the immediate requirements of the shipbuilding industry for the large volume of new construction both for British and foreign owners. Vibration of ships' hulls is a subject in which much full-scale research has been continued, especially on vessels with long superstructures such as passenger liners, and a vibrograph and accelerometer were shown, together with typical records taken at sea.

Research on the design of ships' propellers is carried on principally in the Lithgow water tunnel, which can be operated at reduced pressures to enable cavitation phenomena to be studied. The tunnel is also equipped with apparatus for the measurement of the thrust delivered by the propeller and the shaft horse-power absorbed.

The Light Division displayed an interferometer capable of comparing the flatness of two surfaces up to 12 in. in diameter. The surfaces need not be in actual contact, although their separation should preferably be small. The observer is able to view, at normal incidence, the interference fringes formed between the surfaces, and means are also provided for recording the fringe system photographically. Examination of the record enables departures from flatness of the order of 0·01 microns to be measured.

Among the exhibits in the Photometry Section of this Division was apparatus for studying the spectral response curves of the various mechanisms in the human retina. The principle is to measure the smallest perceptible intensity of a monochromatic test stimulus applied at a particular point of the retina when the latter is brought into various states of adaptation by exposure to a coloured light-field, which may or may not be of the same wave-length as the test spot.

CALORIMETER BUILDING FOR DOMESTIC HEATING RESEARCH AT THE FUEL RESEARCH STATION, GREENWICH

By Dr. A. C. MONKHOUSE

CONSIDERABLE attention has been paid in recent years to the more efficient use of fuel for domestic purposes, and to the development of better appliances for space heating, cooking and water heating. The amount of coal used directly for domestic purposes is about one-quarter of the total coal consumption in Great Britain. If the indirect use as gas, coke and electricity be included, the amount is one-third, or about 60 million tons a year.

Entrance to one of the calorimeter rooms

Improvements in the domestic use of fuel are of vital importance, therefore, in the economic and social life of the community.

The Fuel Research Station of the Department of Scientific and Industrial Research has in the post-war years, in conjunction with other Government departments, research associations and industry, devised and undertaken tests to determine the performance of the various types of domestic appliances, particularly those using solid fuels. These tests involve the measurement of fuel consumption, the amount of heat emitted as radiation and convection, the heat imparted to the water, the loss of potential and sensible heat in the products of combustion, and the quantity of smoke produced. Some measurements, such as those of convection, are with many appliances difficult to determine directly and are usually assessed by a difference figure in the heat balance. To obtain more accurate data of the distribution of heat from an appliance, a special laboratory building has recently been erected at the Fuel Research Station at Greenwich; it was opened for inspection by Sir Edward Appleton on June 30.

The building is a four-story structure occupying a ground area of about 3,000 sq. ft. On the first floor are four rooms or cabinets, 12 ft. square and 9 ft. high, each mounted centrally in a constant temperature chamber 20 ft. square and 26 ft. 6 in. high. In

these rooms, which are, in effect, calorimeters, the appliances to be tested are installed. The rooms are made of ½-in. plywood, birch or gaboon, covered on the inside and outside with copper sheets 2 ft. by 1 ft. 6 in. Plywood has been chosen because of its low heat capacity, consistent with suitable thermal conductivity and mechanical strength. Each copper sheet is electrically insulated from its neighbour. Differential thermocouples are embedded at the mid-points of the copper sheets directly opposite each other on the inside and outside of the plywood, so that the difference between the internal and external temperature of the walls can be recorded. By suitable wiring the temperature difference can be measured through any individual panel, or the average through a group of panels such as a complete wall, floor or ceiling, and the heat-flow calculated. In practice, the calorimeter rooms are calibrated by a series of measurements when known amounts of heat are supplied from an electric heater operated at constant voltage.

An appliance to be investigated is mounted on a grating floor in the room, and the flue outlet connected through an opening in the ceiling to the chimney. The rooms are designed to be air-tight; but the pressures inside and outside are automatically balanced by control of the flow of the inlet air, so that risk of leakage is reduced to a minimum. Air enters the room by a duct and its flow is measured by an orifice plate and is automatically recorded. The arrangement is novel as the appliance can be operated under natural draught conditions, while by use of the balanced pressure system the air flow can be accurately recorded. In addition, an auxiliary fan with a flow meter is mounted above the cabinet and can be used to extract ventilating air if required. The temperatures of the air entering and the products of combustion leaving the room are recorded, and, where required, measurements of the water heated by the appliance. Radiation from the appliance is measured in the room by thermopiles arranged on a travelling arc covering the hemisphere in which the appliance is placed centrally.

Constant-temperature conditions on the outside of the testing cabinets are obtained by controlled air circulation, and a refrigeration plant is also provided to give cool air, when atmospheric temperatures are high or when appliances with a high output of heat are being examined.

The flues taking the products of combustion from the room are lined with stainless steel to enable the soot deposited to be removed without contamination for weighing and analysis. The flues terminate below the roof of the building, and constant conditions are maintained at the exit by a cowl and an injector fan. The smoke content of the gases is measured by projecting a beam of light across the flue on to a photo-electric cell. Two separate light paths are used, one directly across the flue for dense smoke, and the other with an oblique path for the lighter smokes. Electrical supplies to the light projectors and the photo-cell amplifiers are specially stabilized so that the record is unaffected by variation of mains voltage or frequency. The double windows through which the beams of light pass are electrically heated to avoid deposition from the products of combustion. The photo-cell equipment is calibrated by direct determination of the concentration of smoke in the chimney gases.

The control room for the four testing rooms is on the first floor and is 52 ft. long by 10 ft. wide; it is connected by air locks to each of the four rooms. All instrument readings are automatically recorded in the control room, each calorimeter room having its separate panel. The instruments include six-line recording potentiometers and controllers for the constant temperature chamber. Air-flow recorders are mounted underneath the inlet ducts in the control room. Equipment is also provided for the accurate control and measurement of the water supply for measuring the boiler output of appliances.

Laboratory and office accommodation, and fuel storage, are arranged in the building, which forms a complete unit.

The construction and design comprise many novel features, and the calorimeter building should provide more detailed and accurate information of the heat output of domestic appliances and thus point the way to improvements in methods of heating.

OBITUARIES

Prof. Jacques de Lapparent

PROF. JACQUES DE LAPPARENT, the eminent French lithologist, *Correspondant* of the Paris Academy of Sciences, died on May 18 at the age of sixty-five.

Jacques de Lapparent was educated in Paris. The enthusiastic interest which he displayed for minerals during his youth grew with time. The man thoroughly realized the vocation of the boy and, moreover, became a true scientific creator, a scholar backed by an artist.

As a university professor, J. de Lapparent was appointed to Lille in 1913, to Strasbourg in 1919, to Paris (Sorbonne) at the beginning of 1947. Since 1942, he also gave a regular course of geology and mineralogy at the École Centrale des Arts et Manufactures of Paris. His lectures were none the less in the classical style, and his original views and style brought together a select group of advanced students, chiefly in his later years.

Though he was a keen mineralogist and geologist, de Lapparent devoted the greatest part of his career to petrography and lithology. As a naturalist he gathered a great deal of information by travelling through many countries: Great Britain, Finland, Yugoslavia, Greece, French North Africa, French West Africa, and, of course, throughout France.

J. de Lapparent published about a hundred and twenty studies, including his authoritative and inimitable "Leçons de Petrographie", which established his world-wide reputation. Part of his reputation was due to some thirty published studies concerning bauxites and clays. He endeavoured to clear up the mineralogical composition and conditions of deposit of these rocks and earths. He was the first to show that three types of bauxite exist, each of them characteristic of geological phenomena at the age of formation: gibbsite bauxites formed above water-level, boehmite bauxites at water-level, and diaspore bauxites below water-level. Studying clays in a similar broad manner, he showed at the outset that fuller's earths are either kaolinite–halloysite earths, or attapulgite earths, or montmorillonite earths. These two last constituents, both aluminous and magnesian, are of different architectural types. Prof. de Lapparent endeavoured to elaborate an unequivocal classification with the aid of X-ray studies, which specify 7 A., 10 A., 14 A. as the structural spacings for phyllites. At the same time, with his usual well-balanced scientific sense of research,

he explained the geological origin of some montmorillonite clays.

Indeed, Prof. de Lapparent was able to combine the keenest observation of the naturalist, either in the field or in the laboratory, by eye or with the aid of a microscope, with the ability to call upon modern physico-chemical techniques, to contribute to lithological problems. In this respect, it must be emphasized that, though he considered himself a naturalist, he was fully conversant with many physico-chemical methods, procedures and tests, X-ray crystallography being among the most helpful. He was able to grasp very easily the structural work coming from Sir Lawrence Bragg and his school and from Prof. L. Pauling. His aptitude for understanding in quite a short time the geometrical and physical aspects of atomic structures was really amazing. His efforts to introduce into petrography the results of structural X-ray crystallography, made with a pioneer's confidence, began to receive full appreciation in recent years.

J. de Lapparent wrote with a modern style—rather unusual, at least in French scientific papers—which sometimes gave a wrong impression to the reader more accustomed to a bold style supposed to be more fitted to scientific truth. The epigraph introducing one of his books was the famous quotation: "To everyone his own truth"; one of his works bears for title: "Defense de l'attapulgite".

Actually, J. de Lapparent strived to report with a vivid style changes in the earth's crust, because he was himself a living representation of these phenomena. Further, the reader cannot but be impressed by the l nging for truth which inspires J. de Lapparent's works and to appreciate the essential synthesis which appears in them in various guises. Up to the end of his life, Jacques de Lapparent maintained his high standards and his enthusiasm. His loyalty to friends, his charming attitude to all his acquaintances without reference to their position, made him a most attractive personality.

R. J. HOCART

WE regret to announce the following deaths:

Mr. T. R. D. Bell, C.I.E., chief conservator of forests, Bombay Presidency, during 1909–20, on June 24, aged eighty-five.

Mr. Harry Brearley, Bessemer medallist of the Iron and Steel Institute in 1920, known for his work on stainless steel, on July 14, aged seventy-seven.

NEWS and VIEWS

Zoology at Belfast: Prof. T. T. Flynn, M.B.E.

PROF. T. T. FLYNN is to retire at the end of the present session from the chair of zoology at the Queen's University, Belfast, which he has held since 1931. Born in Australia in 1883 and trained at Sydney under W. A. Haswell and J. P. Hill, he developed a natural interest in the anatomy and embryology and reproductive phenomena in marsupials. He maintained this interest throughout his university career, making valuable additions to knowledge in this subject. So recently as 1941, in collaboration with J. P. Hill, fundamental agreement in the mode of formation of the primary germ layers in monotremes and marsupials was demonstrated, while in 1947 strong support was given for the view of a similar mode of formation in birds and an incentive predicated for the re-examination of germ-layer formation in reptiles in the light of the work portrayed. Along with his interest in marsupials and their nearer allies, Flynn contributed work on the Pycnogonida of South Africa, describing ten new species; on corals of the Barrier Reef; on the invertebrate fauna of Tasmania; on rare and fossil Cetacea; and he demonstrated his interest in marine biology as leader of the Australian Antarctic Summer Expedition 1912, and as sole Royal Commissioner for the Tasmanian Fisheries in 1915. In his retirement to Jamaica he hopes to utilize this latter experience in taking a serious interest in the marine biology and fisheries of the Caribbean area, as well as in meeting the demands of the British Museum for local biological material.

On graduating at the University of Sydney, Prof. Flynn was awarded the University Medal and John Coutts Research Scholarship; and later he received the University Medal for his D.Sc. thesis. He was Macleay Fellow of the Linnean Society of New South Wales in 1911, and Rockefeller Fellow during 1930–31; he was elected a member of the Royal Irish Academy in 1934. In the Second World War he was Chief Casualty Officer (Civil Defence), Belfast, and received the M.B.E. for his services. His many friends wish him a happy and fruitful retirement.

Baron Roland von Eötvös (1848–1919)

ON July 27 the centenary occurs of the birth of the distinguished Hungarian physicist Baron Roland von Eötvös, who in 1891 founded the Hungarian Mathematical and Physical Society and was long the president of the Hungarian Academy of Science. Both his grandfather and great-grandfather had held high office under the Austrian crown, and his father Baron Josef von Eötvös (1813–71) was at one time Minister of Public Instruction. Born at Budapest, the younger Eötvös was educated at the University there, but studied later under Kirchhoff, Helmholtz and Bunsen at Heidelberg, and under Franz Neumann at Königsberg. He became a *Dozent* in physics at Budapest, and in 1872, at the age of twenty-four, was appointed to the chair of theoretical physics, and later was transferred to the chair of experimental physics. Known widely for his invention of the torsion balance for the investigation of gravitational anomalies, he was recently referred to by Prof. A. O. Rankine as "the father of geophysical prospecting for oil, even if a hesitant one". He died at Budapest on April 8, 1919, at the age of seventy.

European Meteorological Telecommunications Panel

AN international conference was held in London during July 5–10 to consider the problems which confront European meteorologists in the exchange of weather information. The meeting took place under the auspices of the International Meteorological Organisation, which recently decided to establish a meteorological telecommunications panel under each of its six regional commissions. This was the first meeting of the panel for the European region, and it was attended by meteorologists and telecommunications experts from Belgium, Eire, France, Great

Britain, Italy, Netherlands, Norway (also representing Sweden), Poland and the Occupied Zones of Germany. Observers from the United States Weather Bureau and the International Civil Aviation Organisation were also present. Unhappily, the Danish delegate and his secretary were killed in an air collision over Northolt on the day before the conference opened.

In an address of welcome to the delegates the Secretary of State for Air referred to the growing importance of meteorology to economic problems, and he directed attention to the accuracy of modern weather forecasts—a fact which is frequently forgotten by the public, who tend to stress the occasional failures. Rapid dissemination of weather reports is vital to forecasting. Hitherto the international exchange of reports has been made primarily by wireless telegraphy, but in recent years high-speed teleprinters have been introduced to link several of the countries in western Europe. The conference discussed measures for increasing the efficiency of this international meteorological teleprinter network and for extending it to the countries of central and eastern Europe. For exchanging weather information between Europe and North America, high-speed radio teleprinters are to be used, although it will be necessary to retain a trans-Atlantic cable link as a standby for use when radio fade-outs render the radio-teleprinter channel inoperative. The conference recommended that Great Britain should provide the European terminal for these trans-Atlantic exchanges and should also be responsible for disseminating the American reports throughout Europe by wireless telegraphy and by the European land-line teleprinter network. Great Britain already transmits in high-power broadcasts from Rugby a 'European collective' message, which gives a selection of European weather reports and can be heard throughout the northern hemisphere.

Evolution of the Gene

Prof. A. H. Sturtevant discusses one of the most pressing problems of biology in a recent issue of the *American Scientist* (**34**, 225; 1948). It has been a mystery how new heritable material for the production of new characters originates. When Harland, as the result of his work on cotton, concluded that homology of parts in related species is not correlated with the homology of genes which produce them, another reason was given for disbelief in the value of homology for biological analysis. Sturtevant challenges this view and points out that the polyploid nature of cotton permits the differentiation of two sets of genes in the amphidiploids after their creation. Hence, in one species, one set of genes may control some characters, leaving the other free for differentiation. In a different species the reverse takes place. Sturtevant compares the characters in different species of *Drosophila* and suggests that two organs are homologous if they are conditioned by homologous genes. This implies degrees of homology, since genes may vary from being identical (being allelomorphic mutants), partly homologous to non-homologous. Homology therefore becomes relational and amenable to mathematical treatment rather than absolute.

Sturtevant points out that in a diploid organism all the genes are functional in that the characters they affect are subject to selection. An alteration in any one of them will give rise to a new phenotype. Therefore these genes cannot be spared for other purposes. If, on the other hand, some genes are carried on duplications, these will be surplus to the requirement of the organism and could vary to wide limits without an immediate effect on the individual or even its progeny. He therefore sees a source for new hereditary material in the duplications which constantly occur in most, if not all, living organisms.

Hæmophilia in Dogs

F. B. Hutt, C. G. Rickard and R. A. Field (*J. Hered.*, **39**, 3; 1948) describe the discovery of a sex-linked hæmophilia in dogs. This shows as a lameness and by swellings in various parts of the body when the puppy is six weeks old. Examination showed that the lameness was due to hæmorrhage at the joints. Of seventeen puppies which have been recognized as hæmophilics, not one has been raised to maturity. Several tests for hæmophilia in man were applied to these dogs and were found to give positive results. The breeding histories of the parents of the puppies were known; as a result, it was easily seen that the condition was due to a sex-linked recessive gene called *h*. The importance of the discovery lies in the fact that the comparative physiology of dog and man is well known, and the condition will be of value in research. It is noteworthy that this case in dogs is one of the few sex-linked genes in mammals other than man where seven or eight sex-linked characters are known. The pig has an inherited hæmophilia; but this is controlled by a recessive gene on an autosome. It is probable that paralytic or lame puppies which were destroyed in the past were in reality sometimes hæmophilic. It would be desirable to discover whether any hæmophilic puppies survive to maturity; on the different genetic backgrounds of different breeds, the recessive gene may not always have a lethal effect.

Uganda Forestry Department Report

The report for the year ended December 31, 1946, of the Uganda Forestry Department has recently been issued (Govt. Printer, Entebbe. 1*s*. 6*d*.). The following quotation from a report on forestry in Uganda, by the late Prof. R. S. Troup in 1922, is given in an opening paragraph. "The percentage of timber forest in Uganda is very small compared with that of most timber-producing countries. . . . There does not, however, appear to be any real cause for alarm, provided the existing forest area is strictly maintained, and all accessible forests are brought under systematic management. . . . The preparation of forest Working Plans should be pushed on in all forests which are accessible to regular working. . . . Without Working Plans systematized work is impossible, and there is a strong risk of the forests being overworked and eventually rendered valueless." Uganda is one of the few departments in the Colonial Forest Services which has printed, published and circulated outside the Protectorate a working plan, with several others in hand. This plan is for the Budongo Forest and it undoubtedly saved that forest during the War. It has now been accurately revised for the second period of ten years, 1945–54. The Buganda Forests were exploited heavily during the War in the absence of a working plan, as in so many other parts of the British Empire and elsewhere in the world. The yield is now carefully controlled. The forest policy for Uganda is also being implemented by the systematic reservation of all main watersheds. This annual report shows that forestry and its requirements are thoroughly understood in Uganda.

Sugar Industry of the Caribbean

Sugar still occupies the first place in Caribbean economy, despite the severe and growing competition in other parts of the world. The factors concerned with this economy are considered at length in "The Sugar Industry of the Caribbean", compiled by the Caribbean Research Council (Washington, D.C., 1947. Crop Inquiry Series No. 6). Some Caribbean territories have been unable to withstand competition and have given up sugar cultivation, whereas in others there has been an increase; but increase is most noted in production, not acreage. This has been greatly helped by research work on new varieties more resistant to disease, and the study of pests. Cane breeding is now active in Barbadoes, British Guiana and Puerto Rico. Experimental work with various fertilizers has had useful results, and there has been a great increase in the import of fertilizers. Sulphate of ammonia is the chief fertilizer. The estates without manure now form a minority. Another change in the industry of cane-growing is the increase in mechanization, especially in United States territories. Weeding and harvesting are still done largely by hand. Generally speaking, there is great scope for the use of more machinery as well as for the centralization of production.

Development of British Somaliland

The report on the General Survey of British Somaliland, 1946, conducted under Approved Scheme D484, Economic Survey and Reconnaissance, under the Colonial Development and Welfare Act, records that the 1946 rainfall was higher than average and well distributed (British Military Administration, Burao, Somaliland. Pp. 20+12 pl. 6*s*.). Tribes tended to move more to south-west than south-east and not so far afield from the Protectorate as in the previous two years. This was due to better rainfall in and near the Protectorate, and resulted also in a drawing in of Somali tribes towards British Somaliland. Rainfall and tribal migration maps are appended to the report. Development of water supplies and some minerals should be possible in 1947–48, and if the survey is continued until the end of 1950, a more balanced report, based on the records of a seven-year cycle, should be possible and facilitate the making of definite proposals for developing the country.

Medical Progress in Chile

The Medical Faculty of Valparaiso, formed after a meeting of Chilean medical men convened in March 1912, by Dr. Frederico Engelbach, has, since its formation, planned the publication of an official scientific journal; but for various reasons this has not been possible until this year. Now the first number of this vigorous Faculty's journal, *Revista Medica de Valparaiso*, has appeared. Well printed and tastefully produced, it will appear in February, May, August and November each year and will publish only scientific papers. As the Faculty's president, Dr. R. Gajardo Tobar, says in his editorial, its pages are dedicated to those who have studied phenomena with objective criticism and express their results with the greatest possible precision. The new journal will record the more important themes presented to the Faculty, summaries of the Faculty's meetings and articles by individuals invited to contribute. This first number contains articles on hypertension of nephritic origin, streptomycin and tuberculous meningitis, the therapeutic action of urethane in leukæmia, and varicose veins and their treatment. Medical men in both the Old and the New Worlds will welcome this new record of the work being done in Chile.

British Agricultural Bulletin

British Agricultural Bulletin is a new, illustrated quarterly journal published by the British Council. It is intended for overseas circulation, particularly with a view to the needs of agricultural administrators, university and agricultural college teachers, research workers and large-scale farmers, none of whom have time to digest the vast specialist literature of to-day. In the words of Prof. J. A. Scott Watson's editorial note, its aim is "to put British knowledge and experience at the disposal of the farmers and citizens of other countries" and thus to help them in their efforts to increase the world's food supply. The articles in the first number (Spring 1948) cover a wide field and are written by specialists on the subject in each case. General principles of animal improvement, war-time farming in Cheshire, the resting break in farming systems and new ideas in grain storage are discussed in some detail, while of more general interest is the account given of the aims and organisation of the National Agricultural Advisory Service set up in Britain in 1946. Reviews and advertisements of books form a prominent feature, and a special article in this number is devoted to modern English books on agriculture. In future issues, it is hoped to give some account of such new technical developments or scientific discoveries as seem ready for application to farm practice, and to discuss matters of agricultural finance, economics and education in terms intelligible to the layman. The price for four numbers will be 15*s*. (including postage), payable to the British Council, 3 Hanover Street, London, W.1.

Irish Chemical Association Summer School

A Summer School organised by the Irish Chemical Association and held in Dublin during July 5–9 attracted 130 participants, of whom some thirty came from universities, hospitals and industrial concerns in Great Britain. The courses covered recent advances in various branches of chemistry. Dr. V. C. Barry, research fellow of the Medical Research Council of Ireland, dealt with the subject of chemotherapy with particular reference to tuberculosis. During his lectures he discussed some of the results obtained by the active school in Dublin of which he is the head (see *Nature*, **160**, 800; 1947). Lectures were given on recent advances in the technique of organic chemistry by Prof. W. Cocker, professor of chemistry, Trinity College, Dublin. The last lecture of this particular series was delivered by Mr. E. R. Stuart, Trinity College, Dublin, who surveyed the methods of application of infra-red and ultra-violet radiation to the determination of the structure of organic compounds. Prof. E. J. Conway, professor of biochemistry and pharmacology, University College, Dublin, who has recently returned from a lecture tour in the United States, discussed biological oxidation and reduction, the nature of the cell membrane and the chemical interpretation of the action of hormones and vitamins, and concluded his course with a lecture on the biochemical approach to carcinogenesis. Prof. T. S. Wheeler, professor of chemistry, University College, Dublin, in a course of five lectures, gave a simplified account of the mathematical background of wave mechanics and described

the application of the wave theory to problems in inorganic and organic chemistry. The School was opened by Mr. Michael Tierney, president of University College, Dublin, who referred to the responsibility of the man of science for the uses, good and bad, made of his discoveries.

Physiology and Pathology of Animal Reproduction

At the final meeting on June 30 of the first International Congress of the Physiology and Pathology of Animal Reproduction and Artificial Insemination, which was held in Milan under the auspices of the University and of the Spallanzani Institute, a permanent committee was set up to organise within three years from now another congress on the subject. This committee is constituted as follows: J. Anderson (Kenya), Prof. T. Bonadonna (Italy), Prof. E. Garcia Mata (Argentina), Prof. R. M. C. Gunn (Australia), Dr. J. Hammond (Great Britain), Prof. N. Lagerlof (Sweden), Prof. G. Lesbouyries (France), Prof. B. B. Morgan (United States), Prof. E. Sorensen (Denmark). Prof. N. Lagerlof has been elected president and Dr. Hammond and Prof. Sorensen vice-presidents. Prof. T. Bonadonna, of Milan, secretary general of the first Congress, has been appointed secretary of the committee.

Revue Générale du Caoutchouc

"Rubber Developments" reports that arrangements have been made whereby the old-established monthly journal, *Revue Générale du Caoutchouc*, can be more readily obtained in Great Britain. Recently, the journal has been improved in make-up, and a welcome feature now is the inclusion of summaries in English of the more important articles. Specimen copies of the journal, subscription forms and further information can be obtained from the Secretary, British Rubber Development Board, Market Buildings, Mark Lane, London, E.C.3.

Earthquakes during March and April, 1948

There were at least nineteen strong earthquakes in the world during March, and at least seven during April. The strongest shock during March was probably that of March 3 from an epicentre near lat. 18° N., long. 119° E. off the north-west coast of Luzon, Philippine Islands. It gave ground amplitudes of 160 μ at Kew. The second strongest was on March 1, from an epicentre near lat. 3° S., long. 130·5° E., off the west coast of New Guinea. This gave ground amplitudes of 80 μ at Kew. The deepest shock during March occurred on March 23 from an epicentre near lat. 51° N., long. 155° E., off the southern coast of Kamchatka. The depth of focus was between 200 and 250 km. The only great shock on land was on March 27, when a severe earthquake shook the city of Sucre in Bolivia, causing considerable damage to property, including the cathedral, plunging the city into darkness and cutting off communications with the rest of Bolivia; only three casualties have been reported. An earth tremor on March 16 was felt at Lourdes, Argeles and Bagnères; but no damage is reported. There were no great earthquakes on land during April. The greatest earthquake during April was that on April 21 from an epicentre near lat. 19° N., long. 69·5° W., off the north-east coast of the Dominican Republic, and the deepest (200 km.) was on April 12 from an epicentre near lat. 14° N., long. 90·5° W., off the coast of Guatemala. Reports for these months have been received from the International Bureau at Strasbourg, the Jesuit Seismological Association, the U.S. Coast and Geodetic Survey and the following individual observatories: Cleveland (Ohio), Beograd, De Bilt, Durham, Kew, Stuttgart, Toledo, Uccle, Zurich and the Swiss stations.

Colonial Services: Appointments

The following appointments in the Colonial Services have been announced: R. Wilcox, inspector of mines, Malaya; L. St. Clair Bartholomew, fisheries officer, Uganda; Miss E. B. Cheek, biochemist, Institute of Medical Research, Malaya; D. H. Constable, soil survey officer, Trinidad; J. Fleming, inspector of plants and produce, Nigeria; Miss R. M. Lowe, fisheries research officer, Uganda; L. J. S. Littlejohn (botanist and plant pathologist, Cyprus), soil conservation officer, Cyprus; P. O. Wiehe (plant pathologist, Mauritius), plant pathologist, Nyasaland; J. A. N. Burra (assistant conservator of forests, Palestine), assistant conservator of forests, St. Lucia, Windward Islands; A. B. Walton (senior assistant conservator of forests, Federation of Malaya), conservator of forests, Federation of Malaya; R. J. S. Waddington (inspector of mines, Tanganyika), senior inspector of mines, Tanganyika; J. W. Loxton (superintendent of surveys, Palestine), staff surveyor, Kenya; R. W. Crowther (veterinary officer, Nigeria), veterinary officer, Cyprus; C. M. Anderson (livestock officer, Tanganyika), senior livestock officer, Tanganyika; C. J. Buckley (livestock officer, Tanganyika), senior livestock officer, Tanganyika; J. W. T. Holloway (livestock officer, Tanganyika), senior livestock officer, Tanganyika.

The appointment of J. I. Moggridge (*Nature*, April 24, p. 637) should read "director, Tsetse Control Department, Uganda".

Announcements

The Lister Medal for 1948 has been awarded to Prof. Geoffrey Jefferson, professor of neuro-surgery in the University of Manchester, in recognition of his contributions to "knowledge of the functions and structure of the nervous system, made as a Philosophical Biologist, practising Neuro-surgery". Prof Jefferson will deliver the Lister Memorial Lecture in London in June 1949, under the auspices of the Royal College of Surgeons of England. This is the ninth occasion of the award, which is made by a committee representative of the Royal Society, the Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh and the University of Glasgow.

Dr. J. T. Edwards, who was invited in 1946 by the Egyptian Government to advise on veterinary education in that country, has been awarded the Order of the Nile (Third Class). Not only was Dr. Edwards able to give valuable service to the veterinary schools, but also he devised measures for combating an outbreak of cattle plague which threatened to become a national disaster.

Prof. W. Sierpinski, of the University of Warsaw, and Prof. F. Riesz, of the University of Szeged, have been elected *Correspondants* for the Section of Geometry of the Paris Academy of Sciences.

We have received from Messrs. Johnson, Matthey and Co., 73–83 Hatton Garden, London, E.C.1, a catalogue of chemical compounds of the precious and other metals. This contains the names of many compounds of rare metals as well as those of commoner elements, and standard metals of high purity for spectrographic work.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Unit Cell Measurements of Wet and Dry Crystalline Turnip Yellow Mosaic Virus

CRYSTALS of turnip yellow mosaic virus, kindly sent to us by Dr. Kenneth Smith and Dr. Roy Markham (see *Nature*, July 17, p. 88), were examined both optically and by X-ray diffraction in this Laboratory. The crystals were small, isotropic, less than 0·1 mm. in size and ill-formed, but just sufficiently developed to indicate that they were octahedral bipyramids. The smaller crystals, first observed by Smith and Markham under a 1/12 oil immersion lens[1], are better formed and display a better development of this form. Following Federov's law on the relation between lattice development and crystal form, these crystals should possess a face-centred lattice.

Powder photographs were taken of the wet crystals, in sealed thin-walled borosilicate tubes containing mother-liquor, with copper $K\alpha$ rays obtained by crystal reflexion from pentaerythritol. From photographs taken at specimen-film distances of 30, 35 and 40 cm., the following spacings were recorded: 407 A., 250 A., 211 A., 175 A., 147 A. and 83 A. The spacings observed fit a face-centred cubic lattice with side equal to 706 ± 11 A., and the following reflexions are accounted for: 111, 220, 311, 400, 422 and 660, with a notable absence of the 222 reflexion, suggesting, therefore, that the virus particles are arranged in a diamond type lattice. There must be eight molecules per cell in such a lattice, giving an interparticle distance of 306 A. or 30·6 mμ.

The powder photographs of virus, dried over phosphorus pentoxide and taken at 30-cm. specimen-film distance, have not yielded the same number of reflexions; there being present a strong reflexion at 190 A. and indications of a weak one at about 310 A. In the case of the wet crystals the 220 is the strongest reflexion, and if we assume that this is the same for the dried crystal this gives us a face-centred lattice of side 528 A.

Markham[2] has also sent us crystals that are nucleic acid-free and non-infective, which were obtained from the top layers of centrifuged solutions of the virus. The crystals in this case were smaller in size, but showed the same morphological development and optical properties. A noticeable feature here was the longer exposure time needed (144 hours as compared with 96 hours for the virus crystals) to give even an indication that a low-angle diffraction pattern could be obtained. The low-angle diffraction pattern, although weak, was found to be nearly identical in the measurement of spacings with that of the virus crystals containing nucleic acid. The high proportion of nucleic acid in the virus crystals must contribute effectively to the observed reflexions for the virus crystals, and so it is open to question at this stage whether the intensities of the corresponding reflexions in the two types of wet crystals are the same. This can only be settled with examination of bigger crystal specimens. The measurements, however, from the observed spacings for the wet and dry nucleic acid-free crystals gave cell sides of 725 ± 25 A. and 550 A. respectively. The reliability of these measurements is not as high as that for the virus crystals; but as they stand, the measurements would seem to indicate a slightly larger nucleic acid-free molecule than that containing nucleic acid. For practical purposes, however, one might at this stage assume the same size of hydrated molecule in both the infective and non-infective crystals.

This naturally raises the question of the location of the nucleic acid in the infective crystals. The X-ray evidence by itself at this stage is far too meagre to make any statement about it. It may be situated within the molecule or possibly on those surfaces of the molecule not exerting attractions between the tetrahedrally distributed neighbours. If the differences in cell-size measurement are significant, it might be possible that the nucleic acid in some manner holds the molecule in a tighter mass with the same attractive surfaces remaining unaffected. These questions can only be answered when it becomes possible to compare the wide-angle diffraction patterns of the two types of crystal.

It is most probable that in both types of macroscopic crystal the diamond-type lattice is retained on drying. On observation under the microscope, the virus crystals (those containing nucleic acid) have been observed to shrink homogeneously by about 15 per cent; the earlier part of this shrinkage being reversible. If the diamond lattice is retained, the interparticle distance would be 228 A. (or 22·8 mμ) for the dried virus crystals, and 238 A. (or 23·8 mμ) for the dried nucleic acid-free crystals. Cosslett and Markham, in studying both types of virus aggregated on the electron microscope, support an open packing corresponding to the projection of a diamond lattice on the (110) planes with an interparticle distance of 19·3 mμ for the virus crystals[4].

On the basis of this evidence, it would appear that the interparticle distance of both types of protein can alter on drying by as much as 76–78 A. The nucleic acid apparently has no effect on the forces holding the particles together in either the wet or the dry crystals. A shrinkage of this extent has been found already in the case of tobacco mosaic virus, where at the isoelectric point the interparticle distances change[3] on drying from 175 to 152 A. There is, however, a fundamental difference between these two cases: the tobacco mosaic virus is one of close-packed long rods, whereas in the turnip yellow it must consist of iso-dimensional molecules. Now the change between the wet and dry state of the tobacco mosaic virus is not accompanied by any noticeable alteration of the internal structure of the virus particle. If we make the same assumption for the turnip yellow virus—and this would also be in accord with all recent work on protein structure, particularly that of Perutz—this would imply that in the crystal in its wet state the molecules are separated by a distance of 78 A. of water. The indication is that the individual molecule has a markedly differentiated surface of tetrahedral symmetry, having four faces with a greater affinity for similar faces in other molecules than has the rest of the surface.

Perutz[4] believes that in the case of hæmoglobin there is a layer of 'bound' water attached to the surface of the molecule. Let us make the assumption for simplicity that the virus particle is spherical in shape and that in the wet crystal it is surrounded by a layer of water. Markham has observed that the partial specific volume of the particle is 0·685 and the density of the wet crystal is 1·33 (in sodium

thiosulphate)[5]. A simple calculation from these figures, using the X-ray data as well, shows that the unhydrated particle must have a diameter of 206 A.; meaning, therefore, that there is a layer of water some 11 A. thick surrounding the particle in the wet crystal. This thickness compares rather favourably with the difference in interparticle distances as measured directly by X-rays and by the electron microscope: 228 A. by X-rays, 193 A. electron microscope[6]. The volume of the cell not occupied by the hydrated molecules in the wet crystal is therefore about 86 per cent, which is somewhat greater than the 76 per cent found by Markham for crystals in ammonium sulphate solution; but as we do not know the exact shape of the virus particles the discrepancy between these figures would imply that the particles are not likely to be spherical in shape. A tetrahedrally desegmented sphere, for example, with the same interparticle distance would give a larger volume.

Similar calculations have been carried out for the nucleic acid-free particles. Here Markham has found that the partial specific volume is 0·75 and the density of the wet crystal is 1·305 (in sodium thiosulphate)[5]. If we assume for the moment that the interparticle distance as measured from the dry crystal is the same as that for the dried virus crystals, then the calculations show this time that the nucleic acid-free particle is surrounded by a layer of water some 3 A. thick. In other words, the unhydrated nucleic acid-free particle has a bigger volume than the unhydrated virus particle. We have been informed by Cosslett (unpublished data) that measurements on electron micrographs of the nucleic acid-free material indicate, within experimental error, a particle that is larger than that observed by them for the virus. This seems to be borne out also by the X-ray measurements on the dried nucleic acid-free crystals, but as mentioned previously, we cannot claim sufficient accuracy for this last measurement.

It would be rash at this stage to speculate too freely on the question as to the location of the nucleic acid in the virus molecule from the few observations that have been made to date; but the evidence, scanty as it is, seems to point to the fact that the nucleic acid-free particle has a larger volume than that containing the nucleic acid. This appears to be a paradox—that something containing additional material should occupy a lesser volume than the same thing without the material! The paradox might be resolved by the suggestion that the nucleic acid draws the protein material of the non-infective particles into a smaller volume. Such a suggestion would not be out of keeping with the findings of many workers that it is extremely difficult, in most cases, to separate completely the nucleic acid from the plant viruses, as, for example, in the case of tomato bushy stunt virus.

We still cannot say anything about the shape of these particles. Whatever their shape, however, the force of attraction holding them together must be acting over relatively large areas of the particle which must come into near contact when the crystal dries, and these surfaces can be separated by 78 A. thickness of water containing ions and yet give the structure considerable rigidity. Similar layers of water have been observed in protein crystals; but the largest recorded thickness is 11 A. in hæmoglobin[3]. The importance of these observations is that they demonstrate at the same time a definite external complexity of virus protein and the possibility of maintaining equilibria at long distances in aqueous solution for bodies other than a plate or rod-like shape where it has been previously observed.

J. D. Bernal
C. H. Carlisle

Birkbeck College Research Laboratory,
21–22 Torrington Square,
London, W.C.1. July 9.

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An Optical Analogue of X-Ray and Electron Diffraction Patterns

The bubble model developed by Bragg and Nye[1] gives a pictorial representation corresponding, with a high degree of probability, to the arrangement of atomic sites within a crystalline material. In order, however, to make further progress with the help of this model, it is desirable to produce an experimental technique which will enable some correspondence between the bubble model and the actual degree of order in the crystal to be established.

Perhaps the most convenient method of exploring the regularity of a crystal lattice is by means of X-ray or electron diffraction. With this in mind, some preliminary experiments were performed with bubble rafts made with the help of the Physical Metallurgy Section of this laboratory.

The rafts were photographed on to 35 mm. film at such a reduction that individual bubble images were about 0·2 mm. in diameter. Illumination was by means of two 'Photoflood' lamps symmetrically arranged. The (negative) image of each bubble thus consisted of a thin dark ring enclosing an almost transparent disk which had two dark points (the direct images, by reflexion) of the lamps superimposed on it.

Fig. 1. Diffraction pattern from perfect lattice

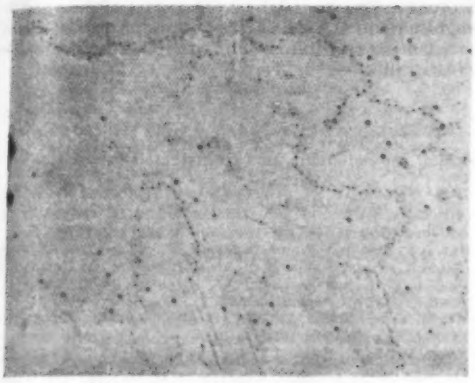

Fig. 2a. POLYCRYSTALLINE BUBBLE RAFT

The individual bubbles are not well shown, due to interference with the half-tone dots. Boundaries of crystal grains may be seen; also most of the dislocations may just be perceived as short dark lines

The developed film was then placed in an optical system which was, in effect, a spectroscope. Light from a pinhole approximately 0·10 mm. in diameter was rendered parallel by a collimating lens of about 35 cm. focal length; it then passed through the film and was observed in a telescope. The light source used was a B.T.H. 250-watt mercury vapour lamp with an Ilford 'Mercury Green' filter.

Each bubble image acts as a scattering centre and diffracts light with a polar diagram depending on its geometry and contrast. Interference between wavelets diffracted from the whole array of images gives a Fraunhofer diffraction pattern corresponding to that given by X-rays or electrons diffracted from a single sheet of atoms.

The pattern given by a perfect lattice is shown in Fig. 1. The photograph gives but a poor impression of the beauty of this pattern, which is especially great if the unfiltered light of the mercury lamp is used. In these circumstances each spot, save for the central one, becomes a short spectrum oriented in a radial direction.

Fig. 2*b* shows the pattern due to the polycrystalline raft shown in Fig. 2*a*. This raft was photographed immediately after growth, and consists of a few relatively large crystals with a certain amount of internal strains and dislocations. As might be expected, the pattern consists of 'spotty' rings, each spot being due to an area of almost perfect lattice. In addition, however, a certain amount of continuous background is evident. This is due in part to scattering from the photographic emulsion, but also in part to diffraction from the small amorphous portions around the grain boundaries.

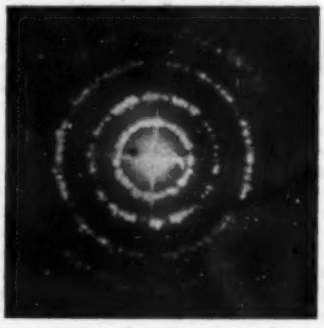

Fig. 2b. DIFFRACTION PATTERN FROM RAFT ILLUSTRATED IN FIG. 2a

The four white arms at right angles in the centre are due to diffraction from the edges of the rectangular aperture used in forming the diffraction pattern in this case

The patterns derived by this technique are more closely related to those obtained by electron diffraction than by X-rays, as in the former case diffraction is due only to a few atomic layers. Fig. 1 bears a close resemblance to the cross-grating pattern obtained by diffraction of electrons through a very thin sheet of mica.

Further work is being undertaken with the object of improving the resolution and illumination of the diffraction patterns.

J. DYSON

Associated Electrical Industries, Ltd.,
Research Laboratory,
Aldermaston Court,
Aldermaston, Berks.
April 2.

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Discrete Sources of Galactic Radio Frequency Noise

IN a recent communication[1] an outline was given of investigations of the variable galactic noise received from the constellation of Cygnus, first noticed by Hey, Parsons and Phillips[2]. The characteristics of the radiation were described, and evidence was given of its origin in a discrete source. A search has since been made over about one quarter of the celestial sphere for other such sources. The region investigated is roughly enclosed by the co-ordinates:

R.A. 8 hr., Dec. + 40°; R.A. 21 hr., Dec. + 40°;
R.A. 4 hr., Dec. − 40°; R.A. 17 hr., Dec. − 40°.

The frequency used was 100 Mc./s., with an overall sensitivity of 10^{-24} watts m.$^{-2}$ (c./s.)$^{-1}$, and the technique and equipment employed were as previously described[1,2].

So far, six new sources have been found. They are listed in the accompanying table together with the

SOURCES OF GALACTIC RADIO FREQUENCY NOISE KNOWN TO FEBRUARY 1, 1948

Temporary designation	Position		Intensity at 100 Mc./s. (watts m.$^{-2}$ (c./s.)$^{-1}$)	Angular width	Type
	R.A.	Dec.			
Cygnus *A* (1·46)	19h. 59m.	+41° 47′	6×10^{-23}	< 8′	Variable
Taurus *A* (2·47)	5h. 13m.	+28°	10^{-23}	< 30°	Probably long-period variable
Coma Berenices *A* (4·47)	12h. 04m.	+20° 30′	$1\cdot5\times10^{-23}$	< 15′	Constant
Hercules *A* (7·48)	16h. 21m.	+15°	2×10^{-24}	< 1°	—
8·48	—	—	2×10^{-24}	—	Constant
5·47	—	—	3×10^{-24}	< 1°	Constant
Centaurus *A* (6·47)	—	—	10^{-23}	< 15′	Probably Cygnus-type variable

source in Cygnus. The positions of three of the sources of northern declination have been computed from the experimental time-elevation curves using the first 20° rise above the horizon. There is an uncertainty of about 1° in the positions given. The source 8·48 rises only shortly before Taurus *A*, and the lobe pattern is then obscured by the stronger source. Similar overlapping of the Centaurus and 5·47 sources has so far prevented their accurate location.

The majority of these sources appear to be in regions of relatively low noise-brightness and star-density. It may be, however, that regions of high noise-brightness are regions of high source-density, not suited to resolution with the present technique. As in the case of Cygnus, the new sources do not appear to be associated with outstanding stellar objects.

The discovery of these discrete sources raises the question of the origin of galactic noise. Henyey and Keenan[4] proposed a mechanism of free-free electron transitions in ionized interstellar matter, with a free space electron temperature of 10^4 ° K. Townes[5] has pointed out divergences between theoretical calculations on this basis and experimental results for the maximum apparent temperatures of the Milky Way, particularly above wave-lengths of two metres. Moxon[6] has shown that the minimum apparent temperature (that is, at the galactic poles) varies as λ^2, whereas the temperature along the Milky Way, after subtraction of the polar residual, depends on λ^3—suggesting a twofold origin. Recent research on solar radiation at metre wave-lengths indicates that radiation from the quiet sun corresponds to a temperature of 10^6 ° K. and is presumed due to thermal emission from the corona. During times of sunspot activity, however, there is evidence that the apparent temperature may exceed 10^{10} ° K. for long periods and be even higher for periods of about a minute.

It is therefore not unreasonable to expect a measurable aggregate of emissions from individual stars in regions of high star-density, despite the large dilution factor. Moreover, it is likely that the free-space electron temperature is greater than 10^4 ° K. in the neighbourhood of *B*- and *O*-class stars.

On the basis of the present observations, it is suggested that the factors contributing to the observed intensity and distribution of galactic noise are threefold.

(1) A 'base-level' due to free-free transitions as proposed by Henyey and Keenan.

(2) An aggregate of emissions from individual stars in regions of high star-density.

(3) A contribution from individual discrete sources, which may be distinct 'radio-types' and for which a place might have to be found in the sequence of stellar evolution. Purely electromagnetic disturbances as an origin of these have been discussed by several writers[7,9,10], and the following additional possibilities are envisaged: (*a*) A pre-main sequence model consisting of a large cool gas sphere, gravitational energy of contraction being radiated in the radio frequency spectrum. (*b*) A post-main sequence model—possibly a development of the planetary nebula consisting of an intensely hot central star, with its radiation in the far ultra-violet, surrounded by a shell of predominantly stripped atoms.

I wish to acknowledge the assistance of Messrs. G. J. Stanley and O. B. Slee in making observations involved in this work, which forms part of the research programme of the Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia.

J. G. Bolton

Division of Radiophysics,
Council for Scientific and Industrial Research,
Australia.
April 6.

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Electric Conductivity of the Ionospheric *D*-Region

Recently, Cowling and Borger[1] have put forward theoretical reasons why the electric conductivity of the ionospheric *D*-region may be considerably less than that of the combined *E*–*F*-regions. On the further postulate that tidal motions increase with height in the ionosphere, they conclude that a recent deduction[2] concerning the origin of the solar and lunar magnetic variations is improbable.

There are two lines of reasoning, both mainly based on experimental evidence, which are difficult to reconcile with Cowling and Borger's conclusion. In the first place, it would appear very doubtful that tidal motions increase with height in the ionosphere. The height gradient of tidal motion depends profoundly on the temperature gradient in the ionosphere, and account must also be taken of the damping due to kinematic viscosity and to conductivity (both thermometric and electric). This damping alone must eventually cause a reduction of motion with increasing height. These considerations are supported by recent experimental evidence[3] that the solar tidal air motion is considerably greater in the *E*-region than in the *F*-region. (The much smaller solar tidal influence on *E*-region ionization is due to the much greater rate of ion production and recombination there.)

Again, recent experimental evidence[4] shows that the phase of the lunar tide in the *E*- and *F*-regions is substantially in opposition to that required to produce the lunar magnetic variations. This suggests strongly that these are produced mainly below the *E*–*F*-regions, and hence that the conductivity there is adequate.

Another argument against Cowling and Borger's conclusion is McNish's experimental evidence[5] that solar flares produce an enhancement, but little change in form, in the solar magnetic variations. It is known that such flares produce negligible changes in ionization in the *E*–*F*-regions, but notable changes in ionization below the *E*-region. Since it is most unlikely that a sporadic disturbance like a solar flare would cause an enhanced air motion identical in form with the regular solar tide, it seems very probable that the main part of the solar magnetic variations is produced below the *E*-region.

Nevertheless, while the weight of experimental evidence strongly suggests that the main part of the magnetic variations is produced below the *E*-region, it is important to reconcile this conclusion with Cowling and Borger's valuable discussion of the relatively small theoretical conductivity likely to be found there. In this connexion the results of an earlier investigation by Cowling[6] may be important. He showed that the conductivity of an ionized medium can become almost independent of the magnetic field if polarization is set up by the Hall current. In the earth's atmosphere the Hall current is produced by the differential motion of ions and electrons across the earth's magnetic field under the influence of the atmospheric tide. Calculation shows that if polarization adequate to equalize the velocities of ions and electrons is set up, then the effective conductivity of levels below the *E*-region will be increased by factors of the order 10^2–10^3.

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D. F. Martyn

Australia House,
London, W.C.2.
April 27.

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We have recently begun to investigate theoretically how atmospheric tidal motions should vary with height above the *E*-layer. The work is still in the exploratory stage, and too great reliance cannot be placed on the tentative results which have so far been obtained. These results, however, suggest that tidal motions should increase with height for some considerable way above the *E*-layer. Considerable phase-changes may also occur above the *E*-layer. Such results are difficult to incorporate into a general theory of the magnetic variations, and we do not claim to be able to do so: but Dr. Martyn's interpretation of the facts need not be the only possible one.

Dr. Martyn's final suggestion will, unfortunately, not wholly resolve the difficulties to which we directed attention. Polarization counters the magnetic reduction in conductivity fully only if the Hall currents are completely prevented from flowing, and in this case the polarization field must considerably exceed the original field which makes it arise. If, say, the Hall currents in the ionosphere were vertical, the polarization produced by accumulations of charge above and below the conducting layer would be only slowly dissipated, and would be able to build up to a size sufficient to produce the desired effect. But normally the polarization electric field has a horizontal part, which makes the polarization charges leak away as fast as they collect. Hence, while polarization may partially restore the reduction in conductivity due to the magnetic field, it cannot do so more than partially.

T. G. Cowling
R. Borger

University College,
Bangor.
May 18.

Electromagnetic Level-Shift and Effect of Radiation Field

The brilliant experiment of Lamb and Retherford[1] has conclusively demonstrated that in the hydrogen atom the $2S$-level is higher than the $2P_{1/2}$-level by about 10 megacycles, a result which reveals a breakdown of the Dirac equation of the electron when applied even to the simplest of the atoms. In a fundamental paper, Bethe[2] has given an explanation of the observed level-shift on the assumption that the transverse self-energy of the electron, in general, depends on the state in which the electron is.

The observed level-shift and Bethe's theory are likely to prove of considerable significance in astrophysics. It is to be observed that the shift in the Balmer lines arising on the above account is comparable to the Einstein solar red-shift. Again, because of the separation between the $2S$- and $2P_{1/2}$-levels the possibility, arising on account of the Stark perturbation, of the (forbidden) transition $2S \rightarrow 1S$, is severely restricted; that is, the $2S$-state would behave as a metastable state, a behaviour which would not have been possible if the levels $2S$ and $2P_{1/2}$ were coincident as demanded by the Dirac equation. The metastable $2S$-state would obviously have an influence on the hydrogen chromosphere. Further, in astrophysical applications, in determining level-shifts, account must be taken of the radiation field surrounding the atom.

It can readily be shown that the transverse self-energy of a free electron is affected by the radiation field, and in the case of temperature equilibrium the increase in the self-energy of the electron is given by

$$\frac{1}{137}\ \frac{\pi}{6}\ \frac{kT}{mc^2}\ kT,$$

where m is the electron rest-mass, k the Boltzmann constant and T the temperature. In the case of atomic levels, the effect of the radiation field becomes complicated (because of the infra-red catastrophe). The details of this investigation will be published elsewhere.

D. S. Kothari
F. C. Auluck

University of Delhi.

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The Proof of Wien's Law

A vital step in the proof of Wien's Law, $E(\lambda,T) = T^5\psi(\lambda T)$, for complete radiation, is the adiabatic change in volume of a cavity filled with radiation. In Wien's first proof (1893)[1] and in the more analytical version of it given by O. W. Richardson[2], the cavity is cylindrical in shape and is provided with a movable piston. In order that the distribution in direction may remain random during the expansion, Wien stipulated that the cavity walls should be "perfectly white" (that is, diffuse rather than specular reflectors).

Larmor (1900)[3] pointed out that the proof is simplified if the shape of the cavity is taken to be spherical; the wave-lengths of all components are then altered in the same proportion. It is not, however, obvious that the distribution in direction is maintained during the expansion if the internal spherical surface is perfectly reflecting. Westphal

(1914)[4] makes the walls of his spherical cavity "white", possibly because of Wien's prescription of white walls for the cylindrical cavity.

Though Larmor's proof has been given in extended form in current texts, it appears not to have been demonstrated that, in the case of a spherical reflecting cavity, the change of angle with the normal which ensues on reflexion at the moving surface is compensated by the change of radius between reflexions. If i, θ are angles of incidence and reflexion respectively as the surface moves slowly outwards with speed dr/dt, $\theta - i = (2 \sin \theta / c) dr/dt$. The angle of incidence i' at the succeeding reflexion satisfies the equation $\sin \theta / \sin i' = 1 + dr/r$, where $dr = (2 r \cos \theta / c) dr/dt$.

Thus $\sin i' - \sin \theta = -(2 \sin \theta \cos \theta / c) dr/dt$, and $i' - \theta = -(2 \sin \theta / c) dr/dt$, giving $i' = i$.

The angle of incidence remains the same at successive reflexions, and we may consider as a distinct group the radiation which is incident at angles between, say, θ and $\theta + d\theta$. If, at some temperature, $u_\theta d\theta$ is the energy density of the group in the immediate neighbourhood of the wall, and u represents the total energy density, it can be shown that $u_\theta = u \sin \theta$, while the pressure due to the group on the wall is $u_\theta \cos^2 \theta \, d\theta$ and the energy of the group in the whole sphere is $U_\theta d\theta = 4\pi r^2 u_\theta \cos^2 \theta \, d\theta$. The energy equation for the group in expansion is then:

$$dU_\theta + 4\pi r^2 u_\theta \cos^2 \theta \, . \, dr = 0,$$

whence

$$r du_\theta + 4 u_\theta \, dr = 0.$$

Comparing this with the equation for the whole radiation

$$r du + 4u \, dr = 0,$$

it is seen that the energy of each group is altered in the same proportion during the expansion, and the distribution in direction is maintained.

Wien (1894)[5] showed that this was true for a group at nearly normal incidence ($\theta = 0$); but the general case appears not to have been discussed. Larmor inserted a material particle in his cavity in order to maintain normal distribution in wave-length; but it is not clear from his argument, which is couched in very general terms, that the calculation of the change of wave-length from the Doppler effect is valid when the particle is present. Planck[6] has shown that for a cavity of any shape, the distribution in wave-length remains normal whether the small material particle is present or not; his demonstration of this, like the proof given by Wien for a cylindrical cavity, is valid only if random distribution in direction is maintained. The spherical reflecting cavity, without a material particle, thus provides a satisfactory proof when supplemented by the demonstration above of the maintenance of random direction and by Planck's proof of the maintenance of the distribution in wave-length.

E. O. Hercus

Department of Physics,
University of Melbourne.

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Photo-electric Star-following Telescopes

Experiments have recently been conducted by the Telecommunications Research Establishment at the Royal Observatory, Greenwich, to investigate the automatic guiding of an astronomical telescope on a star. The work was done on the 13-in. astrographic refractor and the degree of success achieved was as follows.

In June 1947, using a very sluggish servo system, that is, one with a natural frequency of the order of 1/10 cycle per min., the steady state error in follow was less than 1″ (corresponding to an image movement of 0·001 in.).

The irregular refraction of the atmosphere causes the apparent direction of a star to vary at frequencies up to at least one cycle per second. Accordingly, a system with a more rapid response was built. In January 1948, using a servo system with a natural frequency of the order of ¼ cycle per sec., there was a random steady state error of some few seconds of angle, owing to the larger band-width.

The servo system derives its 'knowledge' of misalignment from an error detection device comprising a graticule in the focal plane of the telescope, and in the form of a disk divided into equal sectors alternately opaque and transparent. The image of the star being followed is made to describe a circle over the face of the disk. Behind the disk is a photo-cell which collects the transmitted light in the form of pulses. When the telescope is aligned on the star, the circle of movement of star image is concentric with the disk and the pulses of transmitted light are of equal duration and separation; but when the circle of image movement is eccentric due to relative movement between star and telescope, the pulses then transmitted are effectively modulated in frequency. The amplitude and phase of this modulation give a linear measure to a first order of the telescope misalignment in magnitude and direction. The misalignment signal controls the acceleration of a servo motor which drives the telescope.

Since the astrographic telescope at Greenwich has a fixed plate-holder, guiding is possible only in right ascension; hence only one rectangular component of the misalignment information is required and used.

Consideration is now being given to the use of this or a similar system to guide automatically the 100-in. Isaac Newton telescope planned for erection at Herstmonceux.

A. Uttley
S. Jones
L. Manns

Telecommunications Research Establishment,
Great Malvern.
April 8.

Presence of Cobalt in the Anti-Pernicious Anæmia Factor

Independent investigation here and in the United States led to the recent isolation of the anti-pernicious anæmia factor as red needle-shaped crystals[1–3]. Examination of its ash has now unexpectedly revealed the presence of cobalt.

In four separate batches of crystals we have detected cobalt by the characteristic cobalt blue borax bead and by the specific red colour reaction with nitroso *R* salt. Colorimetric estimations

with α-nitroso-β-naphthol showed the presence of 4·0 per cent of cobalt in crystals dried *in vacuo* at 56° C. If each molecule contains one atom of cobalt, the molecular weight of the compound is about 1,500; allowance for 8 per cent loss on drying brings the value to 1,600, in excellent agreement with that of 1,550–1,750 for air-dried material which Dr. Dorothy Crowfoot (private communication) has found by X-ray crystallography. (The uncertainty is due to the amount of available material having been inadequate for accurate determination of density.) The value does not agree with about 3,000, which we found by the diffusion method. The discrepancy may be due to errors inherent in this method or to the use of impure material in the earlier experiments, but it is also possible that association occurs in solution.

So far as we are aware, the presence of cobalt in an isolated compound of natural origin has not been previously reported, although cobalt is recognized as an essential trace element. It has been shown to prevent or cure in ruminants a syndrome involving anæmia and arising from feeding on pastures deficient in cobalt[4].

In discussion with Dr. Randolph T. Major, of Merck and Co., Inc., we have been informed that the Merck workers have also discovered the presence of cobalt in their vitamin B_{12}. Their publication of this finding[5] refers to the presence of phosphorus. Our own analytical figures have already indicated that the molecule contains three atoms of phosphorus.

E. Lester Smith

Glaxo Laboratories, Ltd.,
Greenford, Middlesex.
July 1.

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Interrelations of the Serum Protein in the Thymol Turbidity Test

The mechanism of the thymol flocculation test developed by MacLagan in 1944[1] has in the past four years been the subject of study by several investigators[2–5]. In the course of a detailed study of the circulating proteins of a patient suffering from advanced liver disease, whose plasma was known to give a strongly positive thymol reaction (18 units), opportunity was taken to examine the observation that normal human albumin would inhibit the thymol reaction[3].

The fraction used for the investigation consisted of the slower moving components, separated from the descending limb, by the discontinuous electrophoretic technique of Tiselius. Fig. 1 shows the distribution of the components in this fraction. It will be seen that there were two major peaks having mobilities compatible with β- and γ-globulins respectively, and one intermediate peak the mobility of which corresponded to fibrinogen. This fraction was dialysed against 0·15 molar sodium chloride at *p*H 7·0, and after dialysis gave a well-marked thymol reaction using the technique originally laid down by MacLagan[1].

To the material so obtained varying concentrations were added of (*a*) crystalline normal human serum albumin in 0·15 molar sodium chloride, and (*b*) normal human serum 'albumin' obtained by precipitation of the globulins of normal serum with 26 per cent sodium sulphate at 37° C. and subsequent dialysis against 0·15 molar sodium chloride. Electrophoretic analysis of (*b*) showed that the fraction contained perceptible amounts of α_1-globulin (see Fig. 2).

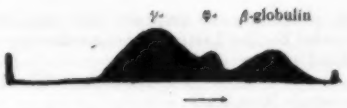

Fig. 1. Phosphate buffer, molarity 0·2; protein concentration, 112 mgm. nitrogen/100 ml.

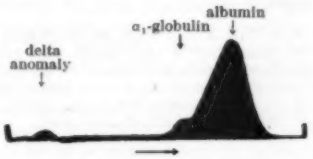

Fig. 2. Phosphate buffer, molarity 0·2; protein concentration, 160 mgm. nitrogen/100 ml.

In every instance the concentration of the globulin fraction in the final volume of saline was kept constant. The results are shown in the accompanying table.

(*a*) Crystalline human albumin Ratio of albumin nitrogen to globulin fraction nitrogen	Thymol test
0 to 1	+ +
0·81 to 1	+ +
1·62 to 1	+ +
3·24 to 1	+
4·77 to 1	−
9·55 to 1	−

(*b*) 'Albumin' obtained by precipitation of globulins from normal human serum with 26 per cent Na_2SO_4 at 37° C. Ratio of albumin nitrogen to globulin fraction nitrogen	Thymol test
0 to 1	+ +
0·28 to 1	−
0·56 to 1	−

The mean ratio of albumin to γ-globulin in eleven sera examined by electrophoretic analysis[6], all giving a well-marked thymol reaction, was 2·6 to 1 (σ = 0·705). This ratio of concentration is lower than that shown in the table as the minimal effective concentration to produce inhibition using normal albumin.

The inhibitory action of pure bovine albumin and of pure horse albumin was studied against the same globulin fraction, and both were found to be effective inhibitors in concentrations of the same order of magnitude as crystalline human albumin.

These results seem to suggest that the inhibitory effect of albumin as such is a function of its concentration in the system under test; and further, that the interaction is not species specific.

The 'albumin' obtained by sodium sulphate precipitation was inhibitory in much lower concentrations than the crystalline albumins. This 'albumin' was demonstrated to be contaminated by α_1-globulin. This raises the possibility that inhibition may be a function of α_1-globulin closely associated with albumin, as well as albumin itself. An alternative rationalization of the observation is that in the process of crystallization, the specific reactive groupings on the albumin molecule have become modified so as to reduce its potential inhibitory effect when redissolved in normal saline.

I wish especially to express my thanks to Dr. Kekwick and to the Lister Institute for the facilities they placed at my disposal.

NICHOLAS H. MARTIN

St. George's Hospital,
Hyde Park Corner,
London, S.W.1.
April 2.

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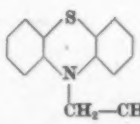
N-Diethylaminoethylphenothiazine: a Specific Inhibitor of Pseudocholinesterase

Mendel and Rudney[1] demonstrated that mammalian tissues may contain two distinct esterases, both capable of hydrolysing acetylcholine *in vitro*: a specific enzyme ('true' cholinesterase) and a non-specific enzyme ('pseudo'cholinesterase). The chemically dissimilar natures of the two enzymes were indicated by their selective behaviour towards particular choline esters[2] and by the selective toxic effects, on the pseudo esterase, of the dimethylcarbamate of (2-hydroxy : 5-phenylbenzyl)-trimethylammonium bromide[3] and of diisopropylfluorophosphate[4]. Both these substances exert powerful effects on pseudocholinesterase at concentrations which are relatively ineffective against true cholinesterase.

Experiments recently recorded in these laboratories indicate another organic compound which exerts a similar selective toxic action on pseudocholinesterase. The compound *N*-diethylaminoethylphenothiazine hydrochloride (also known as 2987 *R.P.*), of the following constitution:



was originally synthesized by Gilman and Shirley[5] and first examined pharmacologically by Bovet *et al.*[6] in connexion with its possible use in the symptomatic treatment of Parkinson's disease. It was tested for anticholinesterase activity, using the technique of Ammon[7]. The source of enzyme was either a rat brain extract, which is believed to contain only true cholinesterase[8], or blood plasma. The brain extract was prepared by grinding a whole rat brain with sand and normal saline, filtering through muslin, and diluting the filtrate with saline to a final volume of 8 ml. per gm. original tissue. Enzyme activities were measured at 37° C., using as substrates acetylcholine, acetyl-β-methylcholine (mecholyl) and benzoylcholine, in presence of various concentrations of 2987 *R.P.*, and measurements of carbon dioxide output in every case were made for a period of 1 hr. after equilibration. Controls without drug and without substrate were also set up. Typical results are shown in the table.

It will be seen that, while the activity of pseudocholinesterase, indicated by the action of plasma on benzoylcholine, is strongly inhibited by 2987 *R.P.* at concentrations of the order of $0{\cdot}075 \times 10^{-4}$ *M* and $0{\cdot}24 \times 10^{-4}$ *M*, the activity of the true cholinesterase, indicated by the action of brain extract on acetylcholine and of plasma on mecholyl, is not affected appreciably by the drug even at much greater concentrations, of the order of $5{\cdot}1 \times 10^{-4}$ *M*.

Source of enzyme	Concentration of substrate	Concentration of 2987 *R.P.*	% Inhibition of enzyme
0·5 ml. brain extract	0·007 *M* acetylcholine	$5{\cdot}1 \times 10^{-4}$ *M*	0
0·5 ml. rat plasma	0·007 *M* mecholyl	$3{\cdot}0 \times 10^{-4}$ *M*	9·2
0·5 ml. rat plasma	0·006 *M* benzoylcholine	$0{\cdot}24 \times 10^{-4}$ *M*	74·0
0·3 ml. guinea pig plasma	0·006 *M* benzoylcholine	$0{\cdot}075 \times 10^{-4}$ *M*	87·3

The results are in harmony with the views expressed by Mendel *et al.*[1,2] regarding the chemically distinct natures of the two types of cholinesterase.

J. J. GORDON*

Biological Division,
May and Baker, Ltd.,
Dagenham, Essex.
March 19.

* Present address: Research Department, Bristol Mental Hospital, Fishponds, Bristol.

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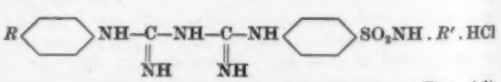
Metachloridine-substituted Aryl Biguanides as Possible Antimalarial Compounds

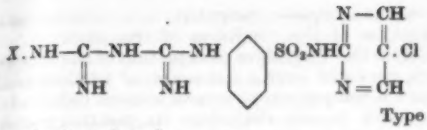
METANILAMIDES are reported to have no antibacterial action[1], and from the parallel nature of the antimalarial and antibacterial properties of sulphanilamides, discouraged research in the field of metanilamides as possible antimalarials. Recently, English *et al.*[2] discovered enhanced antimalarial activity in 2-sulphanilamido-5-chloropyrimidine, and their work resulted in the discovery of metachloridine[3] (*SN* 11437) (2-metanilamido-5-chloropyrimidine), which has been found to be effective both in avian[3] and human malarias[4,5,6]. Metachloridine is 5-chloropyrimidine-substituted metanilamide, the action of which is not affected by the presence of *p*-aminobenzoic acid, and is supposed[3] to have a double mode of action due to the presence of 5-chloropyrimidine and metanilamide parts in the molecule.

Previously, sulpha-biguanides of type (*A*), some of which have shown encouraging antimalarial activity against avian malaria (*P. gallinaceum*), have been reported by us[7,8]. The following compounds of type (*B*) have also been prepared (see table), where metachloridine forms the N^5-substituent of N^1-arylbiguanides.



Type (*A*)

R = H, Cl, Br, NO_2, CH_3, etc.
R' = H, 2-thiazolyl, 2-pyrimidyl, 4 : 6-dimethyl-2-pyrimidyl, 6-methyl-2-pyrimidyl.



Type (*B*)

X = substituted aryls.

N¹-Aryl-N⁵-metachloridino-biguanides

X	M.p. of the hydrochloride (° C.)	M.p. of the free base (° C.)
1. Phenyl	232	234
2. *p*-Chlorophenyl	235	239
3. 2 : 4-Dichlorophenyl	256	234
4. *p*-Bromophenyl	227	243
5. *p*-Iodophenyl	208 (decomp.)	239
6. *p*-Methylphenyl	237	233
7. 3 : 4-Dimethylphenyl	246	232–234
8. *p*-Methoxyphenyl	202	236
9. *p*-Nitrophenyl	252	237

The hydrochlorides of these compounds have been prepared by the reaction of the appropriate aryl-cyanoguanidines with metachloridine hydrochloride in solvents like aqueous dioxan or 90 per cent ethanol. The free bases and the hydrochlorides are white crystalline powders.

During the preparation of the copper chelates of the substituted biguanides of types (*A*) and (*B*) by Andreasch's[8] method, the simple sulphanilamide-substituted aryl-biguanides (type *A*, *R*′ = H) yielded the chelates readily, while those with heterocyclic sulphanilamides and metachloridine as substituents showed very feeble tendency towards chelation, perhaps due to the enhanced electro-negative nature of the sulphonamido group.

m-(5-Chloro-2-pyrimidyl)-sulphonamidophenyl-azo-cyanoguanidine did not lend itself to denitrogenation to give the corresponding cyanoguanidine compound. Details will be published elsewhere.

We thank the Indian Research Fund Association for the award of a fellowship to one of us (H. L. Bami).

H. L. Bami
B. H. Iyer
P. C. Guha

Organic Chemistry Laboratories,
Indian Institute of Science,
Bangalore. Feb. 27.

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Presence of a Parasitic Agent in Various Intracranial Tumours of Man

In a preliminary communication[1], one of us (C. J.) reported how, by following up indications that gliomas of the domestic fowl arise as foci of chronic inflammation and appear to be a response to the presence of some irritant influence, he was led to the demonstration of a parasitic agent associated with the lesions of glioma and encephalitis in this species. Bodies (*A*, *B*, *C* and *D*) were described and illustrated which were claimed to be phases of a pleomorphic parasite, while others (*E*) were strongly suspected, and still others considered possibly to represent further phases. In glioma and in chronic disseminated encephalitis, it was the *C* and *D* bodies that were especially demonstrated, while the *A* and *B* bodies tended to be more characteristic of purulent encephalitis.

These findings made it imperative to examine human gliomas for the possibility of the presence of some comparable agent; all tumours, whether gliomas or not, recently removed in the Neurosurgical Department of the Johannesburg Hospital have therefore been so examined.

The results are shown in the accompanying table.

PARASITIC BODIES IN TUMOURS FROM THE NEUROSURGICAL DEPARTMENT, JOHANNESBURG

Case No.	Diagnosis	Parasitic phases: *C* Bodies	Parasitic phases: *D* Bodies	Strongly suspected phases: *E* Bodies	Possible phases: *F*, *G*, *H*, etc.
1	Medulloblastoma	+	++•	+	
2	Medulloblastoma	+	+•	+	+
3	Medulloblastoma	+	+•	+	+
4	Spongioblastoma multiforme	+•		+	+
5	Spongioblastoma multiforme	+•	+	+	+
6	Spongioblastoma multiforme	+•	+	+	+
7	Spongioblastoma multiforme	+•		+	+
8	Meningioma Type III–IV	+•		+	
9	Meningioma Type III	+•	+	+	+
10	Meningioma Type III	+•		+	
11	Meningioma Type III	+•		+	+
12	Meningioma Type III	+•		?	
13	Meningioma, Spinal, Mixed	+•	+	?	+
14	Meningioma, Xanthomatous	+•	+	+	+
15	Pituitary adeno-carcinoma	+++•	+	+	+
16	Chromophobe adenoma	+•	+	+	+

+ Present. ++ Fairly frequent. +++ Very frequent. • More frequent or prominent than other phases. ? So rare that some doubt was felt.

In all of sixteen cases of glioma, meningioma or pituitary neoplasms, we have been able to demonstrate bodies indistinguishable from the *C* and *D* phases of the fowl parasite, while in most cases the suspicious *E* bodies and the other possible phases have also been seen.

All the varieties of *C* bodies (*C*, oval; C^1, double oval; C^2, piriform; C^3, bipolar; and C^4, ring- or horseshoe-shaped) encountered in the fowl have been identified in man.

It will appear from the table that *D* bodies tend to be more characteristic of medulloblastoma on one hand, and *C* bodies of meningiomas and pituitary tumours on the other. In the meningiomas no correlation could be found between the type of tumour and the variety of the *C* bodies which was predominant. But in the two pituitary neoplasms (one a β-cell adenocarcinoma, the other a chromophobe adenoma) the C^2 variety was predominant, and in these two cases there was a striking contrast in the frequency of the *C* bodies between the malignant and the benign tumour.

Properly differentiated Giemsa-stained paraffin sections of formol-fixed material and air-dried Giemsa-stained smears are both suitable for the demonstration of *C* bodies; but the *D* bodies are best demonstrated only in smears.

The bodies have been readily demonstrable only in a few cases, in other cases they were found after a short search; but in the majority of specimens, considerable and patient searching was necessary.

A full report of these findings will be published later.

We should point out that *D* bodies, considered alone, would probably not impress one as anything more definite than 'inclusion bodies'. On the other hand, *C* bodies might fairly be claimed on their own morphological merits as parasites. However, our opinion of the parasitic nature of the *C* and *D* bodies in human tumours is based chiefly on our ability in avian lesions to relate these bodies as phases of a life-cycle which includes the still more impressive schizont-like *A* body.

By analogy with avian pathology, we expect that a phase corresponding to the *A* body will prove to be demonstrable in man; but not necessarily in tumours, since in the fowl this body is more characteristic of the non-neoplastic lesions. Pending demonstration of the 'missing' phases in man, no opinion will be expressed regarding the identity of the human with the avian parasite.

R. A. Krynauw

Department of Neurosurgery,
Johannesburg Hospital.

Cecil Jackson

Onderstepoort Veterinary
Research Institute,
South Africa.
March 16.

[Jackson, C., *Nature* [161, 441 (1948)].

The Stock of Whales

In an article on the "Effect of Present-day Whaling on the Stock of Whales"[1], Dr. Hamilton points out that in spite of a 'rest' during the War, the Antarctic catch of blue whales in 1945–46 showed a scarcity of the largest animals, a reduced proportion of this species (30·7 per cent) in the total catch, and a reduced percentage of mature females which were pregnant; and he infers that the stock of blue whales is showing clear signs of reduction. Among other matters he points out that the limit of 16,000 'blue whale units' allows the killing of many more than 16,000 whales. Although in agreement with much of what Dr. Hamilton says, I think it should be noted that the figures for the subsequent season of 1946–47 show that blue whales were taken in relatively larger numbers, and formed about 38·5 per cent of the catch. Although this is still not very high, and gives no grounds for complacency, it is a distinct improvement on 1945–46.

It is doubtful whether the results of a single season are sufficient to indicate the condition of the stock, and since the better catches of blue whales in 1946–47 can scarcely be attributed to a sudden recovery in the stock, it is difficult to avoid the conclusion that 1945–46 was in some way an abnormal season in which the blue whales in the population were not adequately represented in the catch. The explanation may be in exceptional oceanographical conditions; but on this we have no adequate evidence. It appears that the weather at least was less favourable in 1945–46 than in 1946–47. Full details of the catches in 1947–48, and of sizes and percentage pregnant in 1946–47, have not yet, I believe, been published. It is not very clear, however, that the percentage of mature females pregnant is a wholly reliable indication of the condition of the stock.

Before the War, signs of depletion of the blue whale stock persisted over a succession of whaling seasons. If now a comparison of several seasons indicated that this stock is still declining, its position would be serious indeed. If, on the other hand, it is found to have recovered to some extent (and there is evidence, as yet unpublished, which suggests good recruitment of young blue whales), then it is important that it should not again be subjected to excessive, and in the long run uneconomic, hunting.

The international regulation of whaling is a complex subject; but briefly it can be said that the limit of 16,000 blue whale units (in preference to a specified number of whales) was adopted as the best practicable means of putting a 'ceiling' to the total Antarctic 'pelagic' catch. It represents approximately two thirds of the average annual catch before the War, and it can be reconsidered from time to time. Since 1 unit = 1 blue, 2 fin, 2½ humpback, or 6 sei whales, the larger the number of whales taken, the smaller will be the number of blue whales among them. This may not be a perfect method of limiting the catch, but it is probably the most effective of the international regulations.

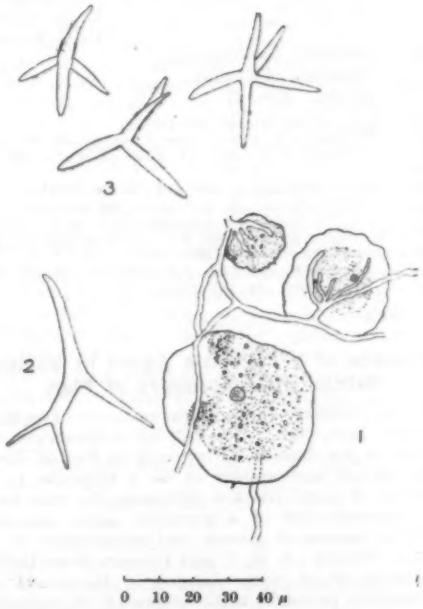
N. A. Mackintosh

"Discovery" Investigations,
Queen Anne's Chambers,
London, S.W.1.

[1] *Nature*, **161**, 913 (1948).

An Aquatic Predaceous Fungus, *Acaulopage dichotoma*, in Britain

In the course of a general investigation into aquatic fungi, a predaceous Phycomycete, *Acaulopage dichotoma* Drechsler (1945) [1], has been identified for the first time in Great Britain.



The source of material was a small pond at Ken Wood, London, containing beech leaf and twig debris. In maize meal agar plates, a fungus was observed which subsisted on aquatic amœbæ. The mycelium is extremely delicate and granular, with slight branching, diameter varying between 1 and 2 μ according to age. Amœbæ, 30–45 μ in diameter, are captured and a branched haustorium 10–30 μ in length is formed which persists until complete digestion is effected, when withdrawal of protoplasm occurs (Fig. 1). When the mycelium is well established, conidia formation occurs, and exposure to light seems to stimulate their formation. A short lateral enlarges and two distal forks appear, frequently one or both forking again (Fig. 2); less regular forking is of frequent occurrence (Fig. 3). At maturity, the distal portion of each fork appears devoid of protoplasm and is termed the appendage. The conidia have forks ranging from 15 to 40 μ in length.

This fungus agrees with the general description of *Acaulopage dichotoma* Drechsler, 1945, found in water-lily leaf inoculum, and is named accordingly.

I found a greater variation in the degree of forking of conidia than is reported by Drechsler, and no trace of the clear secretion which formed yellow deposits apparently produced by the fungus as an adhesive trap for amœbæ.

M. Peach

Department of Chemistry and Biology,
The Polytechnic,
309 Regent Street,
London, W.1.
April 8.

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Osmoregulatory Capacity of Contractile Vacuoles

The view that the contractile vacuoles of Protozoa in many cases perform an osmoregulatory function has been supported by much evidence[1] which need not be repeated here. Recent observations carried out on the freshwater peritrich ciliate *Carchesium aselli* have demonstrated the remarkably close regulation of body volume which is achieved in spite of wide variation in the osmotic stress imposed by the environment.

In some experiments, in order that the internal osmotic pressure might be raised, the organisms were equilibrated with 0·05–0·5 molar solutions of ethylene glycol, which is known[2] to penetrate various cell membranes at a significant but not too rapid rate. On return of the organisms to water free from ethylene glycol, the contractile vacuole increased its rate of output immediately to from two to nine times the rate before treatment; but it subsided in the course of ten to twenty minutes to its normal level of activity, no doubt owing to the escape of the ethylene glycol from the organism. Greatly increased osmotic stress was thus met by increased vacuolar output, and the swelling which would be expected in the absence of osmoregulation was prevented or (after the higher concentrations of ethylene glycol) considerably restricted. Similarly, in experiments in which the organisms were immersed in solutions of up to 0·03 molar sucrose, which for short periods may be regarded as not penetrating in significant amount, the body volume remained unchanged (within the limits of observation) while the rate of vacuolar output was appropriately reduced.

The highly developed power of accurate osmoregulation which is therefore found in these ciliates may well be useful where the osmotic pressure of the medium is liable to fluctuate, as, for example, in estuaries. Apart from this, another important ecological aspect of this question may be suggested. It has been shown[3] for the egg of the sea urchin *Arbacia* that the rate of swelling on transfer to dilute sea water is considerably faster at higher temperatures, presumably because of increased permeability to water; and I have found this to be true also for the marine peritrich ciliate *Vorticella marina*. The Q_{10} for the permeability to water of the *Arbacia* egg has been estimated as ranging from 2·1 to 3·1 ('permeability' here including any changes which may occur either in the diffusibility of water or in the properties of the membrane); and that for *Vorticella marina* appears to be of the same order, although the precision of the results does not warrant a closer statement. But I have also found that the rate of vacuolar output of a freshwater peritrich increases with rise of temperature with a Q_{10} of $2\frac{1}{2}$ to 3.

It seems reasonable to postulate that the contractile vacuole responds to small changes in the hydration of the protoplasm, whether these arise from a change in magnitude of the osmotic difference across the body surface or from a change in 'permeability' of that surface to water, so that the rate of vacuolar output is adjusted to maintain a practically constant body volume. In its natural habitat a freshwater peritrich might be exposed to seasonal extremes of 0–20° C., and in some circumstances the diurnal fluctuations might amount to several degrees. It seems that the organism would have to grade its osmoregulation to meet these changes. This may apply also to other freshwater animals, and so prove to have a general ecological importance.

J. A. Kitching

Department of Zoology,
University of Bristol.
April 9.

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Course of Untreated Infections of *Litomosoides carinii* in the Cotton Rat

The efficacy of drugs in the treatment of human filariasis can be assessed by their effect on the microfilariæ in the peripheral circulation, and the effect on the adults merely inferred therefrom: in animals, however, the change induced in the adults can be assessed directly.

In recent years, *Litomosoides carinii*, the natural filarial parasite of the cotton rat, transmissible from rat to rat by the mite *Liponyssus bacoti*, has been studied in this laboratory and in others in Britain and America, with a view to its use for chemotherapeutic researches in filariasis. Much of the published work on the preliminary screening of drugs has been done with rats showing infections of unknown duration, naturally acquired in the field, and the results are interpreted as indicating that, while certain drugs kill the adult worms in the pleural cavity but do not affect the microfilariæ in the peripheral blood stream, the converse is true of other drugs, although, in some cases, only a transient reduction in the number of microfilariæ has been observed. Our observations on untreated laboratory-infected cotton rats over the past two years lead us

to conclude that there is need for considerable caution in the interpretation of such observations.

In a previous communication[1], the unsuitability of the white rat as a host for this purpose was suggested, for though the course of an infection in cotton rats and white rats follows the same pattern, in the white rat the microfilariæ do not persist in the circulation for the same length of time as in the cotton rat, and the death of the parent worms and their encapsulation occurs much earlier. Though the infection in the cotton rat has the same evolution, there is less disparity between its duration and the life span of the host. Nevertheless a cotton rat infected in its youth may outlive an infection which has undergone spontaneous cure. We have been able to follow, for a year or more, the general course of the blood infection in cotton rats exposed to infection once—usually for 24 hours—by small numbers of infective mites. Microfilariæ appear in the peripheral blood on the fifty-first day after exposure, and increase during the next month or more, after which the count tends to remain more or less constant, with wide variations about the mean. In one rat, still surviving, an infection intensity, varying between 140 and 240 microfilariæ/c.mm., has been maintained for the past twelve months. On the other hand, in another rat, the general level, varying between 80 and 190 microfilariæ/c.mm., persisted for some six months; but, during the following three or four months, the count dropped progressively until the microfilariæ finally disappeared three weeks before the animal's death, when only dead encapsulated worms were found.

In other cotton rats, infected on several occasions by mass exposure to mites, the infection has followed a similar course. Some, which showed counts of 1,500, 840, 675, 450 and 150 microfilariæ/c.mm. in the peripheral blood about the third or fourth month after infection, dropped after the seventh or eighth months to 530, 45, 30, 10 and 20 microfilariæ/c.mm. respectively, while in others, which died seven to twelve months after their last exposure, many of the adult worms were found to be dead and encapsulated.

The relationship between the death of the adult worms and the disappearance of the microfilariæ from the peripheral circulation cannot be defined in the absence of more precise knowledge of the migration-rate and the longevity of the microfilariæ. Though they are found most commonly in the peripheral circulation within one day of injection into the pleural or peritoneal cavities and the subcutaneous tissue, their persistence in the circulation in the absence of the adult varies from days to weeks and even months. Furthermore, in one such animal, a concomitant septic infection has been accompanied by a transient reappearance of the circulating microfilariæ after they had previously disappeared for a time, suggesting that redistribution may be an additional factor in their decline.

Our results cannot be taken to indicate the minimum time required before gross pathological changes are induced in the pleural sac by the adult worms, nor do they enable the duration of a particular blood infection to be estimated before the progressive and terminal fall occurs in the microfilarial count, nor can the disappearance of the microfilariæ and the death of the adult worm be correlated accurately at the moment. Nevertheless, they suggest that conclusions from treated infections should be made with due regard to the findings in untreated controls, and that results derived from wild, naturally infected cotton rats should be interpreted with caution.

W. E. Kershaw
D. S. Bertram
Department of Entomology and Parasitology,
School of Tropical Medicine, Pembroke Place,
Liverpool 3. April 12.

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Density of the Blackfish Petrosal

The mammalian petrosal is generally recognized by anatomists as the most compact of bones. The physical density of the various bones does not seem to have attracted much attention. The only data in the literature available to me are those of the "Smithsonian Physical Tables", where the density of bone is given as varying from 1·2 to 2·0 gm. per cubic centimetre.

Mr. J. T. Sorenson included a petrosal from a blackfish (*Globicephala melæna*) in the collection which he made in his second stay at Campbell Island in the New Zealand subantarctic group. The extraordinary density of this specimen is striking and immediately apparent when the bone is handled. Although the specimen measures only 40 mm. × 28 mm. × 18 mm. in its major dimensions, the dry weight is 17·5 gm. After boiling in water to expel air, the volume measured by immersion is 5·0 c.c.; accordingly, the physical density is 3·5, considerably exceeding the range given in the Smithsonian "Physical Tables".

In comparison, the petrosal of a dog weighed 1·34 gm. and had a volume, measured as before, of 1·0 c.c. The density of this specimen, 1·34, falls well within the limits given in the tables, and confirms the initial impression of the remarkable density of the blackfish petrosal.

L. R. Richardson
Department of Zoology,
Victoria University College,
Wellington, New Zealand.

A Method for Studying the Carbohydrate Metabolism of Micro-organisms

We wish to emphasize the usefulness of the method of paper chromatography of sugar[1,2], especially when applied on a quantitative basis[3], in the study of bacterial metabolism. As an example we quote the following experiment on the utilization of sucrose by *Leuconostoc mesenteroides* (Lister Institute strain No. 3351).

Most strains of this bacterium are found to produce copious yields of a dextran from this sugar and no other[4]. The strain used had those properties.

During the production of the gum, large quantities of reducing sugars are formed, and it has been generally assumed that the glucose part of the sucrose is polymerized to dextran with simultaneous liberation of the fructose moiety[5]. Considerable interest is centred on the bacterium due to Hehre and Sugg's[6] enzymatic synthesis of the dextran.

A loopful of a 48-hr. culture of the organism (growing in Tarr and Hibbert's liquid medium[4] with the addition of 2 per cent yeast extract) was inoculated into 10 ml. of this medium, and the culture flask incubated at 28° C.

It is possible by the paper chromatography method to estimate at any desired interval during growth the

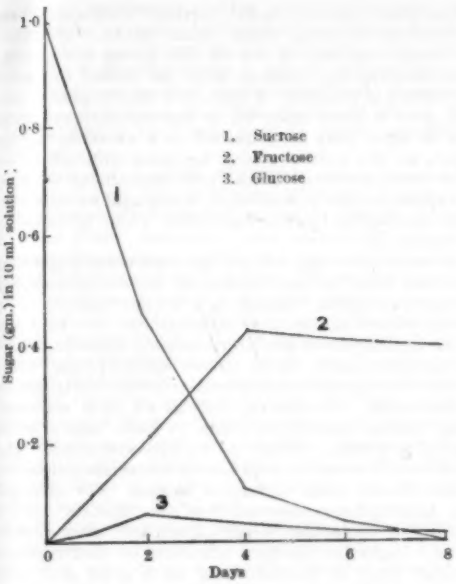

Fig. 1

glucose, fructose and sucrose present in the culture. Instead of using an internal standard[2] which might interfere with bacterial growth, an equal volume (15 μl.) measured by weighing was spotted from the culture on to a paper strip, using a flame-sterilized platinum loop for each spot. Sucrose can be detected on the paper with resorcinol[2] and estimated in the usual manner[3] after a preliminary hydrolysis with dilute oxalic acid. A check was made with known mixtures of the three sugars and nearly quantitative recovery was obtained. The results are plotted on the accompanying graph (Fig. 1) and a photograph is shown (Fig. 2) of a chromatogram obtained after two days growth. It is apparent that glucose as well as fructose is produced, although to a lesser degree. This experiment has been repeated several times with the same general result.

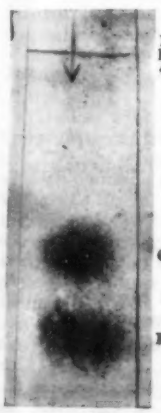

Fig. 2

We shall shortly be preparing a report of the method and further applications for publication in greater detail elsewhere.

W. G. C. Forsyth
D. M. Webley

Macaulay Institute for Soil Research,
Craigiebuckler, Aberdeen. April 12.

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Voltage Effects in Titanate Polycrystals

Titanates of the perovskite type, such as the barium compound, possess ferro-electric properties at temperatures up to the Curie point, at which a λ-transition from a distorted to a cubic crystal structure takes place. Materials of this type possess high permittivities rising to a maximum in the temperature region of the transition. Beyond the Curie point, the relation between polarization and the applied field becomes linear; the ferro-electric influence, however, continues to make itself felt within a temperature region extending well above the Curie point.

In a previous communication[1], we described the variations in permittivity with time observed after the application of a unidirectional electric field to materials of this type. At temperatures below the Curie point, the permittivity was larger shortly after applying a strong D.C. field, and reverted at a decreasing rate to its initial value, within periods exceeding in some cases 30 min. Beyond the Curie point the permittivity had at first a reduced value and again reverted slowly to its original magnitude.

The permittivity of compounds of this type, measured with a small alternating field, is known to be decreased while a strong unidirectional tension is superimposed, at temperatures below as well as above the Curie point[2–4]. As no information appeared to be available on the variations of the permittivity during the application of a polarizing field, it was considered of interest to determine the curves relating the permittivity measured while a D.C. field (3,300 V./cm.) was superimposed to the time of application. At temperatures below the Curie point the permittivity was found to have an increased value on applying the field, and to fall at a decreasing rate to a steady value below that of the initial permittivity. Beyond the Curie point the permittivity decreased immediately and approached again slowly a final lower value.

It appears that the following mechanism may be responsible for the various effects observed. On the application of the field, oriented regions in the material grow at the expense of others, and owing to these changes anisotropic stresses[5] are produced on the crystallites, resulting in the displacement of the Curie point to a lower temperature. In the case of the tetragonal structure, for example, compressive forces in a direction parallel to the *c*-axis may predominate over those along the *a*-axis. At the same time, the maximum in the permittivity – temperature curve will be depressed progressively to lower values of the permittivity, owing to the increasing polarization in the material. On removal of the field, molecules added to the oriented regions revert again to their initial state, and the permittivity – temperature curve assumes its original position. Changes in the volume of the oriented regions, while rapid immediately on applying or removing the field, may continue to take place for comparatively long periods of time. The various effects observed can hence be explained by the depression of the permittivity – temperature curve, accompanied by the slight lowering of the Curie point, on the application of the field.

A similar explanation for the effects observed by us has been suggested by Szigeti[6]. According to this, the changes in the permittivity are due to a displacement of the permittivity – temperature curve by the external field, in a direction parallel to the temperature axis. It is suggested that the permit-

tivity maximum is shifted to a lower temperature, retaining its original magnitude. This explanation, however, would be insufficient to account for the prolonged residual effects observed, if the depression in the permittivity – temperature curve is not taken into account, and without the assumption of a mechanism for the displacement of the Curie point, such as that suggested above.

It is interesting to note in this connexion that the permittivity maximum in this type of material has been reported to occur at lower temperatures in the case of strong A.C. measuring fields than at lower field strengths[7], and the explanation suggested for the residual effects is consistent also with this result.

We wish to thank the United Insulator Co., Ltd., Surbiton, for generously giving us facilities in its research laboratory during part of this investigation. We are greatly indebted also to Dr. B. Szigeti for helpful suggestions.

J. R. Partington
G. V. Planer
I. I. Boswell
Chemistry Department, Queen Mary College,
University of London. April 6.

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Chromatography of Dinitrophenyl Amino-acids and Peptides

Sanger[1] has described the use of 1: 2 : 4-fluorodinitrobenzene to identify the free amino-groups of several proteins, employing the separation of the N-dinitrophenyl amino-acids on columns of silica gel. We have had only limited success applying this method, owing to variations in different batches of the silica gel, and the difficulty of preparing evenly packed columns, which led to diffuse bands, difficult to separate. Sanger stated that with these derivatives on paper chromatograms[2] long diffuse 'tails' formed, making the method quite inferior to the silica method. We are able to report some success with the two-dimensional method, however, without apparently using any special technique which might account for the improvement. Consden *et al.*[3] have also recently described the identification of α-δ-di-dinitrophenyl -ornithine running alone on a paper chromatogram, and Keston *et al.*[4] using the *p*-I^{131}-benzenesulphonyl derivatives of amino-acids have been able to estimate them after their partial separation on a one-dimensional paper strip.

We have tried a wide range of alcohols, phenols, amines, esters, ketones and hydrocarbons, all saturated with water, but with most of these 'tailing' was marked. Best results were obtained with *n*-butanol, phenol, collidine and *n*-butanol-acetic acid mixture, each saturated with water. The solution is applied in the usual manner to No. 1 or No. 4 Whatman paper and neutralized with ammonia vapour before the run. No solvent has so far been found which will satisfactorily resolve the group of dinitrophenyl amino-acids, containing large non-polar side-chains; for example, N-dinitrophenyl-leucine, N-dinitrophenyl-phenylalanine, αε-di-(dinitrophenyl)-lysine, etc., as the addition of the large dinitrophenyl-group still further diminishes the differences between these amino-acids. However, provided that only a few of this group are present, identification by running with the added authentic derivative is possible. 5 μgm. of a dinitrophenyl acid will give a good spot on a one-dimensional strip, but 20 μgm. may be required on a two-dimensional sheet, as the yellow colour becomes difficult to see after two traverses. Ultra-violet examination[4] shows the spots as pale yellow when weak, and as obscuring dark patches in larger quantities. There is no actual fluorescence.

Some months ago, Sanger (private communication) reported that he had separated some dinitrophenyl peptides on silica columns in a similar manner to his dinitrophenyl amino-acid separations. We find that if the hydrolysis of the dinitrophenyl peptide or protein is incomplete, extra yellow spots appear, which do not correspond to the position of the dinitrophenyl amino-acids. Further hydrolysis of such materials after elution has shown them to have been dinitrophenyl peptides, of size up to heptapeptides. This good spot formation with heavy materials extends to those of very large molecular weight. For example, the dinitrophenyl derivative of the 'protein' part of insulin of molecular weight 5,000 left after chymotryptic digestion[5] (before addition of dinitrophenyl groups) runs in phenol-water as a good spot with R_F 0·56. This material and also the mixture of relatively small peptides (average, pentapeptide) from the insulin digest, before treatment with fluorodinitrobenzene, either gave no bands on paper chromatograms in the case of the heavy insulin 'core', or a diffuse overlapping mixture of bands in the case of the peptide mixture.

D. M. P. Phillips
J. M. L. Stephen
Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.
March 22.

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Influence of Hydrogen Ions and Neutral Salts upon the Hydration of Interstitial Connective Tissue

When a piece of interstitial connective tissue covering the thigh muscles of a rat was placed in water adjusted to *p*H 4·5, within a few hours it became opaque, white and shrunken. On the other hand, a piece treated at *p*H 11·0 became translucent, grey and swollen. These changes were mutually reversible and could be repeated several times. Observations with the dark-ground microscope showed that this swelling was not due to any change in the collagen fibrils but to a widening of the spaces between them; shrinkage was accompanied by an obliteration of such spaces and by a condensation and crimping of the collagen bundles.

Clearly, an explanation of these changes must involve a consideration of the nature of the substance which lies between the collagen fibrils. Flemming[1]

described a substance in this situation which, on account of its property of contraction in weak acids, he referred to as the cementing substance. He considered the substance to be a mucin. Recently[1], I have shown that its chief characteristics are those of a protein. Following what has been said above, it should be added that this protein reacts strongly with water.

According to modern theory[2,4], the degree of hydration of a protein at different concentrations of hydrogen ions will depend upon the ionization of the NH_3^+ and COO^- radicals of the side-chains. Near the iso-electric point, a maximal number of the side-chains will be oppositely charged. The attraction of opposite charges will bring the side-chains together and result in a more compact structure with exclusion of water. On the alkaline side of the iso-electric point there will be suppression of charge on the cationic centres of the protein. A large proportion of side-chains will therefore come to possess the same negative charge and their mutual repulsion will open up the structure and lead to swelling. Theoretically, therefore, the properties of connective tissue described above are those of a protein having an iso-electric point in the region of *p*H 4·5.

Schade and Menschel[5] have shown that neutral salts may cause swelling of connective tissue. I have found that this effect is morphologically identical with that which occurs in conditions of reduced hydrogen ion concentration, and also that the reaction involved has the following features: (1) At neutrality the smallest concentrations of various salts necessary to cause swelling lie between $M/5$ and $M/20$. (2) While swelling, the tissue withdraws salt ions from the surrounding solution. (3) The capacity of a salt to cause swelling is greater with reduction of hydrogen ion concentration from the iso-electric point. (4) Although, in general, the actions of salts and hydrogen ions on the hydration of connective tissue are opposite and reversible, salts have no capacity to 'unlock' tissue which has become shrunken by prolonged treatment at a *p*H value near the iso-electric point.

It is clear that the hydration of connective tissue by the action of neutral salts is accompanied by some sort of union of salt with the protein. Probably the salt ions combine in some manner with protein side-chains. To do so, such side-chains must be available and not involved in electrovalent links with oppositely charged side-chains. Perhaps this is why salt has only a feeble 'unlocking' effect on tissue constricted by treatment near the iso-electric point of the interfibrillary protein, and also why, with decrease in hydrogen ion concentration away from this iso-electric point, the hydrating effect of the salt is so much greater.

It is apparent that salts exert a hydrating influence on connective tissue in physiological concentrations. This fact alone must be a matter of considerable importance not only to biological science but also to clinical medicine.

T. D. Day

Department of Pathology,
St. Thomas's Hospital Medical School,
London, S.E.1.
March 21.

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Tetrahydrofuran Hydroperoxide

A study has recently been made in these laboratories of the liquid-phase oxidation of ethers. The products of oxidation may be satisfactorily accounted for by the formation of an intermediate hydroperoxide and its subsequent decomposition. As with the hydroperoxides of hydrocarbons, those of ethers are apparently often too unstable for isolation; but in the case of tetrahydrofuran the hydroperoxide has been isolated in the pure state.

The hydroperoxide obtained by the removal of unchanged tetrahydrofuran at low pressure from a sample which had undergone oxidation by prolonged exposure to air during storage was a liquid (n_D^{20} 1·6933) at room temperature. The product gave on analysis C 46·0, H 7·9 per cent (required, C 46·1, H 7·7 per cent) and liberated the theoretical quantity of iodine from acidified potassium iodide. The hydroperoxide was completely miscible with water and soluble in the common organic solvents (acetone, methanol, acetic acid), and strongly catalysed the polymerization of styrene and methyl methacrylate. The onset of thermal decomposition occurred in the range 70–80° C., and rapid heating to 100° C. did not cause detonation, though the decomposition became more violent at still higher temperatures. The normal reagents for the destruction of peroxides (ferrous sulphate, sodium hydroxide, etc.) were equally efficacious in the case of tetrahydrofuran hydroperoxide, the chief product of both the thermal and catalysed decompositions being γ-butyrolactone. The formation of γ-butyrolactone may be accounted for by loss of water:

though the fact that tetrahydrofuran hydroperoxide is a polymerization catalyst indicates that some homolytic decomposition also occurs, probably by fission of the O—O bond.

A complete account of this work will be published elsewhere.

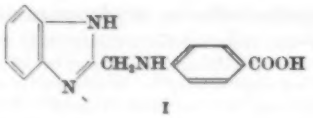
A. Robertson

Imperial Chemical Industries, Ltd.,
Billingham Division,
Billingham, Co. Durham.
March 17.

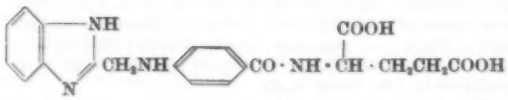
Benziminazole Analogues of Pteroic and Pteroylglutamic Acids

In the course of experiments on the relationship of structure to biological activity in the folic acid series of growth factors, we have examined the benziminazole analogues of pteroic acid and of pteroylglutamic acid[1].

The compound (I), m.p. 281° (decomp.), in which the 2-amino-4-hydroxypteridyl residue (numbering according to the "Ring Index", Reinhold, New York, 1940) of pteroic acid is replaced by a benziminazole ring, was prepared from 2-chloromethylbenziminazole[2] and *p*-aminobenzoic acid in boiling alcohol, or *via* its ethyl ester, from ethyl *p*-aminobenzoate (found: C, 66·8; H, 4·7; $C_{15}H_{13}O_2N_3$ requires C, 67·4; H, 4·7 per cent). The benziminazole analogue of pteroylglutamic acid was obtained as a



I



II

diethyl ester (m.p. 125°) by the condensation under similar conditions of 2-chloromethylbenziminazole and ethyl *p*-aminobenzoyl-*L*-glutamate (III). Hydrolysis with cold aqueous alcoholic sodium hydroxide gave the required acid (II), isolated as a hydrochloride, m.p. 201° (found after drying at 100° in a vacuum: C, 55·6; H, 4·7; N, 12·6; Cl, 8·1; $C_{25}H_{25}O_5N_4HCl$ requires C, 55·5; H, 4·9; N, 12·9; Cl, 8·2 per cent).

The *p*-aminobenzoylglutamic ester (III) is conveniently prepared by refluxing a solution of *p*-nitrobenzoyl chloride in benzene with ethyl glutamate hydrochloride, followed by catalytic reduction of the product. The *p*-aminobenzoylglutamic acid obtained by hydrolysis of (III) has m.p. 167° and in *N* sodium hydroxide solution, $[\alpha]_D^{25°} = +29·2°$, comparable with the recorded value for the *D*-isomer of $[\alpha]_D = -27·4°$ [3]. Published accounts[4] of the preparation of *p*-nitrobenzoylglutamic acid from glutamic acid recommend the use of excess *p*-nitrobenzoyl chloride. We have found that by the simultaneous addition of the acid chloride (1 mol.) dissolved in dioxane and of an equivalent of 2*N* sodium hydroxide to a solution of glutamic acid (1 mol.) in its equivalent of *N* alkali, *p*-nitrobenzoylglutamic acid of m.p. 114–116° and $[\alpha]_D^{25°} = +16·9°$ can be obtained in 70–80 per cent yield[5]. A full description of these experiments will be published in due course.

It has recently been found by Edwards, Starling, Mattocks and Skipper[6] that the benziminazole (II) replaces 'folic acid' as a growth factor for *Strep. fæcalis* R. (though at much higher concentrations), and also stimulates growth in presence of sub-optimal concentrations of folic acid. Similar experiments by us have, however, given different results. For *Strep. fæcalis* R., grown in the improved medium of Rabinowicz and Snell[7], modified by the omission of glycine and asparagine and by the inclusion of pyridoxin (100 μgm./l.), adenine and guanine (each 5 mgm./l.), the benziminazole (II) (10^{-9} to 10^{-3} *M*) did not replace pteroylglutamic acid. Growth was measured turbidimetrically after 20 hr. incubation at 37°. Nor was the organism stimulated in the presence of sub-optimal amounts of pteroylglutamic acid, but, on the contrary, under the latter conditions, growth was inhibited, although this inhibition was not observed when pteroylglutamic acid was added in amounts which afforded optimal growth in the absence of (II). Tests made with *Lactobacillus casei*, using the medium of Roberts and Snell[8] and estimating growth turbidimetrically after incubation for 22 hr. at 37° in an atmosphere of 95 per cent hydrogen, 5 per cent carbon dioxide, gave essentially the same results.

INHIBITION OF GROWTH OF *Strep. fæcalis* R. BY THE BENZIMINAZOLE (II) IN PRESENCE OF PTEROYLGLUTAMIC ACID

Pteroylglutamic acid (molar conc.)	Benziminazole (II) (molar conc.)	Absorptiometer reading*
0	10^{-3} to 10^{-9}	0·00
10^{-9}	0	0·44
"	10^{-7}	0·43
"	10^{-5}	0·37
"	10^{-3}	0·28
2×10^{-9}	0	1·05
"	10^{-4}	0·82
"	10^{-3}	0·52
$1·6 \times 10^{-8}$	0	1·57
"	5×10^{-4}	1·50

* Averages of quadruplicate tubes after incubation for 20 hr.

It is possible that the discrepancy between our results and those of Edwards *et al.* may be due to variations in the respective media. It is noteworthy that the medium used by the American experimenters gave measurable growth for *Strep. fæcalis* R. in the absence of added folic acid. Unlike that described by Edwards *et al.*, which was acetate buffered and contained adenine, guanine, xanthine and uracil, the medium we have employed was buffered with citrate and contained neither xanthine nor uracil. In the light of recent work in this field[9], differences in the pyrimidine-purine content of the two media may well be significant.

The simple benziminazole (I) also, when tested with *Strep. fæcalis* R., was found to be inhibitory, though less so than compound (II), and was inactive as a substitute for pteroylglutamic acid.

F. E. King
P. C. Spensley
Dyson Perrins Laboratory,
R. H. Nimmo-Smith
Department of Biochemistry,
University of Oxford.
April 3.

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The Sommelet Reaction

In a communication under this heading in *Nature* of May 8, p. 723, Messrs. Anyal and Rassach refer to a paper by Graymore and Davies[1], in which it was shown that a mixture of benzylamine and formaldehyde gives benzaldehyde in good yield on heating in solution with hexamine. They say that, contrary to Graymore and Davies' findings, benzaldehyde can be obtained from benzylamine hydrochloride in the absence of hexamine. In a later paper by Graymore[2], it is shown that hexamine may be dispensed with, and benzaldehyde produced by heating methylene benzylamine (or, for that matter, a mixture of benzylamine and formaldehyde) with two-thirds of the quantity of hydrochloric acid, as required by the equation:

$$(C_6H_5CH_2.N{:}CH_2)_3 + 2HCl = 2C_6H_5.CH_2.N{:}CH_2.HCl.$$

It was hoped to obtain benzylidene methylamine from methylene benzylamine, but the attempt failed, the experiment resulting in the formation of benzaldehyde, methyl benzylamine and dimethyl benzylamine. Work is, however, still proceeding in this field.

John Graymore
Plymouth and Devonport Technical College.
June 29.

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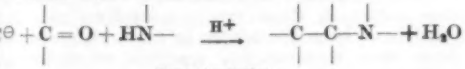
BIOGENESIS OF THE STRYCHNOS ALKALOIDS

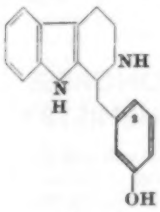
By Prof. R. B. WOODWARD
Converse Memorial Laboratory, Harvard University

ROBINSON[1] and Schöpf[2] have developed with conspicuous success the concept that a fundamental reaction of biogenesis involves the condensation between an amino (or imino) group, a carbonyl group and an anionoid centre:

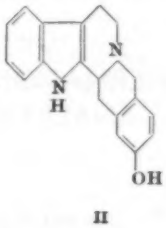


Type *A* reaction

In a particular application of this idea, Hahn[3] has suggested that in the biogenesis of the alkaloids of the yohimbé group, tryptamine, from tryptophane, and 3-hydroxyphenylacetaldehyde (or an equivalent), from 3-hydroxyphenylalanine, condense by reaction (*A*) to give (I), and that from (I), by another reaction

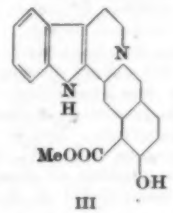


I

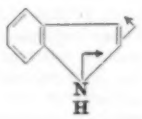


II

of type *A*, involving in this case formaldehyde (*or* an equivalent), N^b and the anionoid 2-position of the aromatic nucleus, (II) is produced. The latter contains the complete ring skeleton of yohimbine (III); the further changes necessary for the elaboration of (II) into (III) would not be unusual, and the various possibilities need not be discussed here.

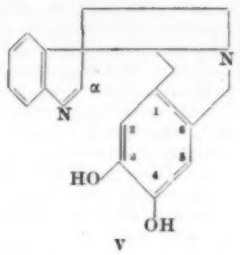


III

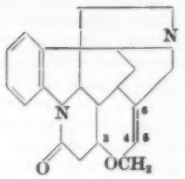


IV

It is well known that the indole ring possesses anionoid reactivity at the β- as well as at the α-position, in consequence of the availability of electrons through the process shown in (IV, arrows). Consequently it is of interest to inquire as to the course of the reactions outlined above if condensation were to occur at the β- rather than the α-position. It is clear that, in this case, if 3,4-dihydroxyphenylalanine be considered the precursor, the product corresponding to (II) will be (V). It will be seen at once that the expression (V) contains striking similarities to many of the features of the strychnine molecule (VI). Moreover, the further elaboration of (V) in the direction of (VI) would involve for the most part relatively simple changes. Thus, since —CH = N— is equivalent to —CHO NH_2—, the opportunity is present in (V) for a further reaction of type *A*, leading to the establishment of a new

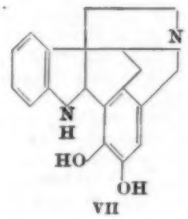


V

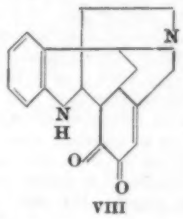


VI

bond, as required, between the α-position of the indolenine nucleus and the anionoid 2-position of the carbocyclic ring. Steric considerations might bar this reaction in this simplest form, since the product, (VII), contains a double bond in an unusual position. On the other hand, it has been shown recently[4] that the *meta* positions of an aromatic nucleus can be bridged by a chain of five atoms, and, in any event, the reaction could lead to an unstrained tautomer of (VII), for example, (VIII); or alternatively, the condensation could occur at a later stage, since in the subsequent stages C_3 is likely still to bear the oxygenated substituent necessary for the conference of anionoid properties on C_2. Further, the (presumably, but not necessarily, oxidative) breaking of the carbocyclic ring (of V, VII *or* VIII) between the hydroxyl-bearing atoms C_3 and C_4 gives at once the system necessary for the formation of the seven-

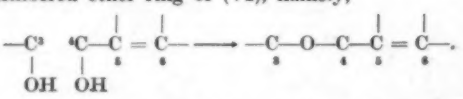


VII



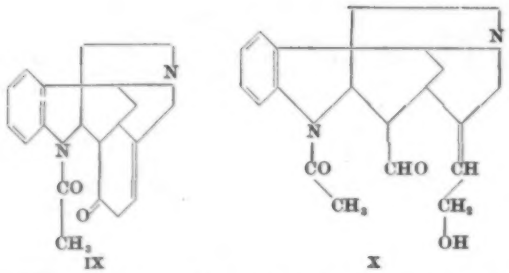
VIII

membered ether ring of (VI), namely,



Apart from changes in the oxidation state of the molecule, the only further modification necessary for the construction of (VI) involves the interpolation of the two carbon atoms necessary for the completion of the lactam ring of (VI). It must be admitted that, at present, this part of the scheme appears to possess unusual features, and a detailed discussion of the various possibilities is scarcely justifiable. On the other hand, it may be noted that the acetylation of N^a (*cf.* aspidospermine, which may well contain a similarly situated *N*-acetyl group, and colchicine, as an example of the occurrence of acetylation in the biosynthesis of alkaloids), followed by condensation between an oxygenated cationoid function at C_3 and the reactive methyl group of —$\overset{|}{N}$COCH$_3$, would lead to a six-membered lactam ring.

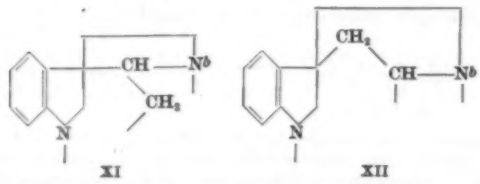
Clearly the scheme as a whole is a flexible one, and many specific variants might be considered. If, for example, the intermediate (IX) were reached, through the initial participation of 3-hydroxyphenylalanine, as assumed by Hahn in the case of the yohimbé alkaloids, or through reductive processes from (VII)



IX X

or (VIII), the opportunity exists for a variant of the well-known photolytic cleavage[5] of cyclic ketones, leading to (X); the conversion of (X) to strychnine itself (VI) would involve simply a single further reaction of type *A*, in which —OH replaces —NH_2. Further, it should be pointed out that the order of the stages indicated should not be considered fixed. Thus, the aldehyde component might enter the scheme after some modification of the carbocyclic ring has already occurred. For example, the condensation of tryptamine, a formaldehyde equivalent, and a *dihydro-derivative* of 3-hydroxyphenylacetaldehyde could lead directly, by the reactions indicated above, to (IX) (acetyl group missing). Finally, the possibility may be kept in mind that preliminary oxidation of the indole nucleus at the α-position might serve to force the initial condensation exclusively into the β-position.

On the whole, the possibility of building up so complicated a structure as (VI) by a series of simple reactions from plausible starting materials is so striking that it is difficult to believe that the scheme lacks significance. It is worthy of note that biogenetic considerations of this kind several years ago led us to consider that the environment of N^b in the strychnine molecule was that shown in the part structure (XI) rather than that (*cf.* XII) accepted at that time[6]. We felt, however, that in view of the



XI XII

relatively undeveloped state of knowledge in the field of biogenesis, the proposal of these considerations as a possible biogenetic scheme should follow rather than precede the definite chemical proof of the primary consequences of its acceptance. Since this proof has recently been brought to a successful conclusion in our Laboratory[7], our confidence in the scheme is sufficient to bring us to suggest that other alkaloids will be found which owe their genesis to less, or more, complicated variants of the same process, and investigations in this direction are already in progress.

[1] Robinson, *J. Chem. Soc.*, **111**, 876 (1917).
[2] Schöpf, *Z. angew. Chem.*, **50**, 787, 797 (1937).
[3] Hahn and Ludewig, *Ber.*, **67**, 2031 (1934). Hahn and Werner, *Ann.*, **520**, 123 (1935). Hahn and Hansel, *Ber.*, **71**, 2192 (1938).
[4] Prelog and Wiesner, *Helv. Chim. Acta*, **30**, 1465 (1947).
[5] Ciamician and Silber, *Ber.*, **41**, 1071, 1928 (1908); **43**, 3140 (1910); **46**, 3077 (1913).
[6] Holmes and Robinson, *J. Chem. Soc.*, 603 (1939).
[7] Woodward, Brehm and Nelson, *J. Amer. Chem. Soc.*, **69**, 2250 (1947).

SIR ROBERT ROBINSON writes:

When in New York in early 1947, I learned from Dr. Woodward that he had developed a scheme of biogenetic relations between strychnine and yohimbine. The details now available follow well-trodden paths in most respects; for example, the β-condensation would be included in any such hypothesis. The suggested fission of a benzene nucleus is, however, highly original. This daring speculation must be judged at this stage by 'the degree of coincidence' which called for it.

In the thirty years that have elapsed since my first paper on these topics, considerations of this kind have been constantly in mind and conclusions have been reviewed and modified when necessary. I therefore feel justified in stating that in my opinion Woodward's theory is probably correct in essentials. May I also venture to deprecate in advance a flood of further speculation on similar lines, unless it is supported by a comparable 'degree of coincidence'. It is obvious that by chopping up benzene rings and recombining the fragments, almost any kind of structure can be obtained.

INTERNATIONAL CONGRESS ON ANALYTICAL CHEMISTRY

AN International Congress on Analytical Chemistry, organised under the auspices of the Netherlands Chemical Society, was held at Utrecht during June 1-3. The president of the Congress was Prof. C. J. van Nieuwenburg, of Delft Technical University, and the general secretary, Dr. H. A. J. Pieters, of the Central Laboratory of the Netherlands State Mines. The Congress was divided into five sections dealing with: (I) general methods and standardization, (II) electrical methods, (III) emission spectrography, (IV) optical measurements and physical methods of separation, (V) microbiological methods and detection of traces. The proceedings consisted of thirteen formal lectures and the reading of forty-five original papers. Full-length pre-prints of the papers had been distributed before the Congress, so that after a short summary by each author most of the time was available for discussion. The proceedings were conducted in English, with French as the second language. The lectures and papers contributed to Sections I, II, IV, and V will be published in a special number of *Analytica Chimica Acta*, and those to Section III in *Spectrochimica Acta*.

The Congress was attended by about forty British analysts and by representatives from Belgium, Czechoslovakia, Denmark, France, Switzerland, and Sweden. Papers were also contributed from the United States. Holland was represented by more than two hundred and fifty chemists and physicists.

Visitors to the Congress could not be unimpressed by the great changes that analytical chemistry has undergone in recent years. Because of the demand for greater speed and accuracy and because of the need for handling much smaller quantities of material, the old classical methods based on gravimetric and volumetric procedures are being replaced by physico-chemical techniques. As a result of this development, the status of analytical chemistry is being raised to a much higher level, and analytical chemistry is becoming a science for the specialist.

Modern analysis, with its interests in optical, electrical and microbiological techniques, makes very great demands on the training of its practitioners, and it was emphasized by speakers from several countries that the training of analytical chemists lags a long way behind the requirements of modern industry.

Prof. van Nieuwenburg, in his opening address to the Congress, remarked that most of the developments in modern analytical chemistry had originated in the requirements of industry, and pointed out that this was borne out by the type of papers contributed to the Congress. He commented on the high cost of modern analytical equipment and said that much of it could only be purchased by the larger industrial laboratories; even these have to make a selection from the wide range of available instruments. An opportunity for the exchange of experiences gained in different laboratories with these modern techniques, such as was offered by the Congress, was most useful, and the dissemination of information in this way might lead to a saving of both time and money that might have been spent on inappropriate or useless equipment.

Most of the lectures and papers dealt with problems arising directly from the demands of industry. Dr. E. C. Wood, in his lecture on statistical aspects of chemical analysis to Section I, discussed the methods of sampling which enable the information sought by the analyst to be obtained as economically as possible. He stressed the need for proper randomization both in sampling and in performing analyses, and gave a short account of the use of 'quality control' charts in analytical work. He directed attention to the possibility of estimating the standard error from the range and described a method for extracting the maximum information from analytical investigations involving the estimation of a ratio. The advantages of the 'factorial' as opposed to the 'classical' type of experimental design was demonstrated and reference made to the value of carrying out an analysis of variance when examining the experimental data. Mr. W. J. Gooderham described and demonstrated his soap-film apparatus for the continuous analysis of coal gas.

Prof. E. Leclerc lectured to Section II on electrical methods of analysis. After reviewing the available methods and discussing their speed and accuracy, he described their applications in the Belgian metallurgical and petroleum industries. Prof. C. Duval spoke on automatic gravimetric analysis in inorganic chemistry and described some new polarographic procedures. Mr. E. Loeuille (Section III) discussed the possibilities and limitations of quantitative spectrographic analysis.

The lectures to Section IV were given by Prof. G. Duykaerts and by Dr. T. I. Williams on absorptiometric methods in chemical analysis and on chromatography respectively. Dr. Williams dealt with partition chromatography, the chromatography of inorganic substances, and the theory of chromatography. He described how the urgency of the Plutonium Project had stimulated work on the theory of chromatography. Dr. W. F. J. Cuthbertson lectured to Section V on recent developments in microbiological assay. He described the different techniques by which micro-organisms may be used for the assay of vitamins and amino-acids, and indicated possible future developments. Prof. A. G. Bertrand spoke on the determination of trace elements in plants and animals.

Dr. H. W. Thompson addressed the final session of the Congress on methods based upon infra-red and ultra-violet measurements. He reviewed the war-time achievements of infra-red analysis in the petroleum field and gave a critical survey of the available commercial instruments. Prof. P. E. Wenger summed up at the conclusion of the Congress.

A high scientific standard was maintained throughout the Congress, which was held in the pleasant rooms of the Esplanade, Utrecht's modern theatre. The Dutch organisers are to be heartily congratulated on the excellent way in which the Congress was arranged.

METABOLIC ASPECTS OF CONVALESCENCE*

THE fifteenth meeting of the Conference on Metabolic Aspects of Convalescence was once again one which devoted the greater part of its deliberations to one particular topic; on this occasion the subject was "Isotopes".

Put together in printed form, the discussions make an extremely useful review of the rapidly widening application of this comparatively new technique for the study of biological problems. Already we have been forced to revise many of our long-held beliefs regarding the nature of the metabolic processes of the body. Interpretations which provided plausible explanations of previously recorded data no longer suffice. As one member of the Conference put it, "The availability of these materials [isotopes] as tools for biological experimentation will have as profound and stimulating an effect on biological and medical science as did the discovery of the microscope". Work already completed suggests that this remark is no exaggeration.

As with all newly developed techniques, however, there are pitfalls for the unwary. In this instance, in addition to the usual initial difficulties of use and interpretation, there is the physical danger of radiation injury to the workers and assistants in the laboratories concerned. Since the hazard is an invisible one, the victim remains unaware of his injury until material damage has been done. With the present rapidity of spread in the use of radioactive materials it is inevitable that they should sometimes be handled by individuals unaware of the danger, and the part of the Conference report which deals with the diagnosis of early radiation injury and the precautions that should be taken to prevent tissue damage should be carefully studied. A statement from the National Cancer Institute is included which says, *inter alia*, "It must be emphasised that the absorption of radiation is always connected with damage, no matter how small the dose. It must also be emphasised that radiation effect may be cumulative." This places a heavy responsibility on the directors of laboratories in which work of this nature is in progress. There must be no repetition of the sufferings of the early radiologists.

In addition to the discussion of these practical issues, there are detailed considerations on the measurement of isotopes, on the synthesis of labelled compounds, and on their use in clinical investigations and in the treatment of disease.

* Conference on Metabolic Aspects of Convalescence. Transactions of the Fifteenth Meeting, New York, 31st March, 1947. Pp. 163. (Josiah Macy, Jr. Foundation, 565 Park Avenue, New York 21.) 2.25 dollars.

In all these the reader has the advantage—inherent in the form in which these transactions are published—of not only learning what an experimenter has to say about his work, but, in addition, seeing the comments it elicited from other keenly interested participants. The question and answer, and the pooling together of small observations which, in isolation, might seem unimportant or meaningless, encourage a clarification and building up of ideas. The contrasting styles of the different contributors also make the reading of these publications much more enjoyable than the reading of some technical journals in which the papers have been so zealously 'edited' that all trace of individual style of expression has disappeared.

The remaining topics discussed at this fifteenth meeting were mostly concerned with hormone studies, and several of the papers consisted in the presentation of further data from work which had already been reported at earlier meetings. The interdependence of the multifarious metabolic activities which take place in the human body and the consequent folly of trying to interpret any one in isolation become more and more evident as each set of these transactions is put together.

M. W. GRANT

MECHANICAL FOAM FOR FIGHTING PETROL FIRES

FOAM for dealing with petrol fires can be generated in two ways: by chemical reaction (chemical foam), or by mechanical agitation (mechanical or air foam). Mechanical foam is largely used in Great Britain and is produced by churning up air and water with a foam-stabilizing agent, such as saponin or soap. The foam-making branch pipe is the apparatus in general use by fire services.

The use of foam appears to have been originally suggested by Laurent in 1904. He successfully demonstrated at St. Petersburg the use of chemical foam against burning naphtha. In 1912, the first foam fighting apparatus for fire-brigade use was introduced into Britain. By 1939, one or two efficient foam compounds were available; but they were both expensive and made from imported materials. With the outbreak of hostilities there came the probability of a large increase in the incidence of petrol fires and also the danger of a shortage of raw materials. Consequently, at the request of the Ministry of Home Security, Research and Experiments Department, an investigation into the whole problem of suitable foaming agents for combating fires of inflammable liquids was undertaken at the Chemical Research Laboratory of the Department of Scientific and Industrial Research. The experimental team was under the leadership of Dr. N. O. Clark, who is the author of Chemical Research Report No. 6: "A Study of Mechanically Produced Foam for Combating Petrol Fires" (London: H.M. Stationery Office. 2*s.* 6*d.* net), in which full details of the problem, the course of the researches and the results obtained are given.

Large-scale methods were developed which permitted a quantitative estimation of the value of foam as a fire-fighting agent, and also a laboratory technique was devised for the investigation of the physical properties of foam. The nature and properties of suitable foaming agents, such as chemically broken down hoof and horn meal, or glue mixed with materials similar to soapless shampoos or chemically treated blood, were elucidated. The use of chemically treated blood—a waste material from abattoirs—as a foaming agent was discovered by the research team. This new compound had the additional advantage of a much lower viscosity than other types and so could be used without modification in R.A.F. crash tenders. It produces a high-efficiency foam for combating aircraft fires, and during the War production was devoted entirely to this particular type of foam.

On the purely scientific side, quantitative evidence was obtained in favour of Plateau's classical theory of foam stability. It would appear that the expansion property depends on the interfacial tension, air/liquid, at the appropriate age of the surface, and the rate of diffusion of the active material into the surface, and is limited by the energy-level of the method of preparation. The hydrolysed proteins are, for example, slow in diffusing into the surface of their solutions. A close relation was shown to exist between the critical shearing stress of a foam prepared from a liquid with appreciable solidity in its surface to that of the corresponding liquid surface.

For the first time, a proper scientific background to the problem has been established, and the 'figure of merit' of foam on a petrol fire can be roughly estimated, but not accurately predicted, from laboratory measurements of the properties of foam, the most important being heat resistance, expansion, and petrol resistance. There is still need for relating laboratory experimental data with those of large-scale tests.

S. WEINTROUB

LINEN INDUSTRY RESEARCH ASSOCIATION

THE report of the Council of the Linen Industry Research Association, Belfast, for the year ended September 30, 1947, states that the strengthening of the financial position of the Association, which now includes practically all the firms in the industry, has permitted the Council to proceed with the Director's plans for expansion, and the new buildings have been commenced. In addition to the large shed with a floor space of 9,800 sq. ft. for technological researches on line and tow preparing, dry spinning and weaving, which forms the main extension, the new plans include the provision of more staff amenities and facilities, extension of the testing-room and further space and equipment for research in bleaching, dyeing and finishing. Reference is made to the co-operation in research which has already flowed from the liaison service described in the last annual report. Comprehensive surveys of conditions of temperature, humidity and ventilation in wet spinning mills have brought to light many striking anomalies, and have led to suggestions by which decided improvements can often be introduced very economically into the working conditions by comparatively simple measures.

Studies in the retting of different types of straw by various methods in the large-scale retting tanks have continued, and in view of the larger differences in yield caused by variations in weather conditions during field-drying of the retted flax, attention has

been focused on treatments to prevent such micro-biological deterioration. Investigations are being continued to improve the efficiency of fibre extraction by turbine scutching machines. An investigation for the Ministry of Supply has shown that the strength of flax yarn depends on the fibre-breaking stress, the fineness and the length of the fibre strands in the raw. A study has also been made of the levelness of rayon staple yarn spun on flax machinery, and one commenced on the suitability of flax machinery for spinning wool, alone and mixed with other fibres. The possibilities of automatic winding and weaving are being studied, while research on bleaching and dyeing continues to have as its object the development of existing methods and investigation of new ones to improve the quality of the product. In finishing research, the study of the application of crease-resistant finishes to linen fabrics has figured prominently and the possibility of fixing both finishes and protective agents by chemical combination with the cellulose has been examined.

Some six hundred testing reports have been made to members, and much cloth testing, chiefly the measurement of tearing and tensile strength, has been undertaken in connexion with the development of new types of flax canvas. Special attention has also been directed to the influence of the micro-structure of flax fibres on the behaviour of flax materials, both during processing and in service.

EDUCATION IN AND FOR THE SERVICES

ALTHOUGH the education authorities of the three Services—Royal Navy, Army and Royal Air Force—frequently collaborate and meet to pool experiences and thrash out problems common to all, it was probably for the first time that all three met by invitation to present their case and reveal their main objectives and the problems which they entail to an audience of nothing but civilian educationists on July 14 at the Conference on "The Education of the Young Worker" organised by the Department of Education of the University of Oxford and held at Manchester College, Oxford, during July 12–17.

The case for the Royal Navy was presented by Instructor-Captain F. C. Sobey, director of studies, H.M.S. *Kestrel*, Winchester; that for the Army (Royal Army Educational Corps) and the Army Cadet Force by Brigadier W. G. Pidsley, deputy director of Army education, and Brigadier H. Kenyon, deputy director cadets, respectively; and that for the Royal Air Force by Group-Captain I. B. Hart, deputy director of education. The meeting was held under the chairmanship of a civilian, Mr. L. J. F. Brimble.

Mr. Brimble emphasized the exceptionally difficult problems which arise in Service education—problems which are often not appreciated by its critics. Now that the Services, particularly the Army, have to deal with National Service entrants, their subject-material is not just a cross-section of the public; indeed, it is almost the entire public at the age of 18–19 plus years. Service intakes at these age-levels include all grades of intelligence and all standards of educational attainment from illiterates up to university graduate level. In most areas there are not enough men or women to warrant segregation into groups according to standard of intelligence or achievement, so that frequently many different grades have to be taken together, though, of course, individual teaching and training are not overlooked. This is, perhaps, the greatest imaginable challenge to the ingenuity of the education officer or instructor. As an illustration, Mr. Brimble described a lecture-discussion which he recently led with Army men of Higher School Certificate standard and upwards, and compared this with a lecture he gave soon afterwards to a group of Army near-illiterates of ages 19–25 years in which only one had ever heard of Faraday and only two of Gladstone. In these two cases, he had his audiences segregated, which made matters much easier than they frequently are in the field.

Group-Captain Hart stated that in the Royal Air Force there are two main educational aims—education for the Service itself and education for the individual. Naturally one aim helps the other, so the distinction between the two is more imaginary than real, and both aims are integrated and correlated wherever possible. Education for the Service is compulsory, whereas that for the individual is mainly voluntary. By and large, the scheme works well in spite of two main difficulties: (1) the peripatetic nature of most Royal Air Force personnel which can frequently upset completely even the best-devised schemes, and (2) the lack of qualified instructors—a lack which is at present common to all educational projects, both Service and civilian.

Brigadier Pidsley gave a very lucid account of the recently planned scheme for the Army which, he emphasized, is still only of an interim nature since the Army itself has still to settle down to a peace-time footing. The Army absorbs the majority of National Service entrants (it is composed roughly of half regulars and half National Service men); but despite the movable nature of Army men and units and the shortage of trained instructors, the scheme, like that of the Royal Air Force, is getting well under way. Just as in the Royal Air Force, units are sent to many parts of the Commonwealth, etc.; but wherever they may be, the presence of the Royal Army Educational Corps is felt. Some units are isolated and there the ingenuity of the instructors is taxed to the limit; other units are near big towns where civilian educational facilities are available to Army men and women. The Army educational scheme is very flexible though it has three broad aims: (1) to make a man a soldier; (2) to train him in good citizenship; and (3) to enable him to develop along the best lines as an individual. Broadly speaking, Brigadier Pidsley claimed that the Army education scheme has got its horse to the water; now it is the job of the Royal Army Educational Corps to see that it drinks.

Speaking for the Army Cadet Corps, Brigadier Kenyon claimed that its educational and training scheme has a real moral purpose behind it and he described various means whereby this purpose is being achieved. The wide variety of interests, both cultural and vocational, inherent in such groups of boys is recognized and catered for so far as is possible. Though religion is recognized and encouraged, politics, and especially party politics, are not. Everything is dealt with on a voluntary basis; nothing is forced upon the boys.

As was clearly stated by Instructor-Captain Sobey in a stimulating yet amusing contribution, the case for the Royal Navy is somewhat different from those of the other two Services. The Navy has few problems arising as a result of the intake of National Service men because that intake is so small—at the rate of about two thousand a year. There is no ship, how-

ever, no matter how small or large, and no shore establishment, where there is not at least one well-qualified instructor, and in some ships such as large aircraft carriers and certain shore establishments there are several instructors. Training is, of course, mainly technical; but wider vocational and cultural interests are accepted and encouraged.

It was of interest to note that in all three Services current affairs and citizenship loom large and are compulsory. There are few subjects which appear in a civilian adult education programme which do not appear in the curricula of Service educational schemes. The ultimate aim of linking up and integrating Service education with the national civilian education should in due course be achieved with little or no difficulty.

FORTHCOMING EVENTS

Tuesday, July 27—Friday, July 30

SOCIETY FOR APPLIED BACTERIOLOGY (at Queen's University, Belfast).—Annual General Meeting and Summer Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN THE AGRICULTURAL BOTANY DEPARTMENT, a LECTURER (Grade III) IN DAIRY CHEMISTRY, and an ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary, North of Scotland College of Agriculture, 41 Union Street, Aberdeen (July 31).

LECTURER IN PHYSICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 31).

H.M. INSPECTORS OF FACTORIES—The Secretary, Ministry of Labour and National Service (O.E.11), 80 Pall Mall, London, S.W.1 (July 31).

SENIOR LECTURER IN CHEMISTRY, and ASSISTANT LECTURERS (one primarily in Botany and one primarily in Zoology) IN THE DEPARTMENT OF BIOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (July 31).

LECTURERS IN (*a*) PHYSICS with subsidiary MATHEMATICS, (*b*) ELECTRICAL AND MECHANICAL ENGINEERING—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (July 31).

SECRETARY OF THE DEPARTMENT OF PHYSICS—The Cavendish Professor, Cavendish Laboratory, Cambridge (July 31).

RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING, a RESPONSIBLE LECTURER IN MECHANICAL ENGINEERING, and a RESPONSIBLE LECTURER IN CHEMISTRY—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 31).

ASSISTANT PHYSICIST—The Secretary, Royal Northern Hospital, Holloway, London, N.7 (July 31).

PSYCHOLOGIST—The Secretary, National Hospital for Nervous Diseases, Queen Square, London, W.C.1 (July 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Leeds 2 (July 31).

ASSISTANT AGRICULTURAL ECONOMISTS (3, male)—The Secretary and Registrar, The University, Bristol (July 31).

FOULERTON RESEARCH FELLOWSHIP IN MEDICINE—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (August 1).

LECTURER IN PHARMACOLOGY—The Secretary and Registrar, The University, Bristol 8 (August 1).

PHYSICIST—The Secretary, British Jute Trade Research Association, Bellfield Street, Dundee (August 14).

POWER HOUSE SUPERINTENDENT in the Power House of the Fertilizer Factory, Sindri, Bihar—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 333A. (August 14).

LECTURERS IN (*a*) ENTOMOLOGY, (*b*) GENETICS, and (*c*) INSECT PHYSIOLOGY, in the Department of Zoology and Applied Entomology—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (August 17).

SENIOR PRINCIPAL SCIENTIFIC OFFICER at the Royal Observatory, Greenwich—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2207 (August 20).

CHEMISTS (men and women) in the Grades of Scientific Officer Class and Experimental Officer Class, for analytical work in connexion with atomic energy development, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.78/48A/2 (August 24).

PRINCIPAL SCIENTIFIC OFFICER, and SENIOR SCIENTIFIC OFFICERS, in the Engineering Division of the Atomic Energy Research Establishment, Harwell, Berks—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2205 (August 26).

CHIEF TECHNICAL INSPECTOR in the Ministry of Pensions—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2218 (August 28).

ASSISTANT TO THE PROFESSOR OF BOTANY—The Registrar, Trinity College, Dublin (August 30).

KEEPER OF ANTIQUITIES—The Director, Museum and Art Gallery, New Walk, Leicester (August 30).

DIRECTOR (Professor or Reader) OF THE UNIVERSITY OF MADRAS BIOCHEMISTRY LABORATORY—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (India, August 31).

SENIOR LIBRARY ASSISTANT (graduate, preferably in Science or Economics)—The Registrar, University College, Southampton (August 31).

SCHOLARSHIP for training in INDUSTRIAL RESEARCH—The Director, Institute for Industrial Research and Standards, 45 St. Stephen's Green, Dublin (September 1).

MAMMALOGIST (male), and an ORNITHOLOGIST (male)—The Director, Transvaal Museum, P.O. Box 413, Pretoria, South Africa (September 30).

METEOROLOGISTS for the East African and West African Meteorological Services—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1.

LABORATORY ASSISTANT/STEWARD FOR PHYSIOLOGY—The Head of the Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3.

GRADUATE IN PHYSICS OR CHEMISTRY in the Intelligence Division for Literature Research—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

LABORATORY STEWARD (Grade II)—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

RESEARCH STAFF in the categories of PHYSICS, CHEMISTRY (mainly Physical), and ENGINEERING—The Director, Gas Research Board, 1 Grosvenor Place, London, S.W.1.

PHYSICISTS to work on problems connected with the measurement of motion and forces in winding and weaving machines, and to investigate problems of cloth structure and serviceability—The Director, Linen Research Institute, Lambeg, Lisburn, N. Ireland.

LABORATORY TECHNICIAN (Grade C) IN THE BIOLOGY DEPARTMENT—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

LECTURER IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

RESEARCH BIOCHEMIST IN THE DEPARTMENT OF PATHOLOGY—The Director of Pathology, Bernhard Baron Memorial Research Laboratories, Queen Charlotte's Maternity Hospital, Goldhawk Road, London, W.6.

LABORATORY ASSISTANT (man) at Westminster Secondary Technical School, Ebury Bridge, London, S.W.1—The Education Officer (Estab. 2), London County Council, The County Hall, London, S.E.1.

SPECIAL DEMONSTRATORSHIP IN THE DEPARTMENT OF BACTERIOLOGY AND IMMUNOLOGY (to work principally at St. Albans)—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

RESEARCH STUDENTSHIPS IN THE DEPARTMENTS OF BOTANY, CHEMISTRY, PHYSICS and ECONOMICS—The Registrar, University College of the South-West, Exeter.

LECTURER or ASSISTANT LECTURER IN PURE MATHEMATICS, a LECTURER or ASSISTANT LECTURER IN PHYSICS, and a LECTURER IN ZOOLOGY—The Registrar, University College of the South-West, Exeter.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Bristol: Department of Economics (Agricultural Economics). The Fruit Growing Industry in Kent. By L. Napolitan. Pp. 223–318. (Bristol: The University, 1948.) 5*s.* [185

Commonwealth Bureau of Horticulture and Plantation Crops. Technical Communication No. 19: Seed Production of European Vegetables in the Tropics. By A. G. G. Hill. Pp. 28. (Aberystwyth: Commonwealth Agricultural Bureaux, 1948.) 2*s.* [185

Commonwealth Bureau of Plant Breeding and Genetics. Technical Communication No. 14: Technique of Breeding for Drought Resistance in Crops. By T. Ashton. Pp. 34. (Aberystwyth: Commonwealth Agricultural Bureaux, 1948.) 2*s.* 6*d.* [185

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1946–1947; Programmes of Experiments, Season 1947–1948. Pp. ii+152. (London: Empire Cotton Growing Corporation, 1948.) 3*s.* [245

Other Countries

Proceedings of the American Philosophical Society. Vol. 92, No. 2: Studies of Historical Documents in the Library of the American Philosophical Society. Pp. 75–126. (Philadelphia: American Philosophical Society, 1948.) 1 dollar. [253

Annals of the New York Academy of Sciences. Vol. 49, Art. 4: Hemorrhage. By Gregory Shwartzman, C. H. Best, Robert Chambers, Charles S. Davidson, John H. Ferguson, Robert F. Furchgott, I. E. Gerber, Magnus I. Gregersen, Paul György, Russell L. Haden, C. Hyman, L. B. Jaques, Paul Klemperer, R. E. Lee, C. N. H. Long, Dickinson W. Richards, Jr., R. H. Schneider, Ephraim Shorr, Henry J. Tagnon, S. A. Thayer, Lee C. Underwood, Donald D. Van Slyke, Alfred E. Wilhelmi and B. W. Zweifach. Pp. 483–660+5 plates. (New York: New York Academy of Sciences, 1948.) 3 dollars. [253

Conference on Metabolic Aspects of Convalescence. Transactions of the Fifteenth Meeting, New York, March 31–April 1, 1947. Edited by Dr. Edward B. Reifenstein, Jr. Pp. 163. (New York: Josiah Macy Jr. Foundation, 1948.) 2.25 dollars. [253

Phytopathological Classics. No. 8: Observations, Botanical and Physiological, on the Potato Murrain. By M. J. Berkeley; together with Selections from Berkeley's Vegetable Pathology. Made by the Plant Pathology Committee of the British Mycological Society. Pp. 108. (East Lansing, Mich.: American Phytopathological Society, 1948.) 1.50 dollars. [253